Inter Office Memo

ATARI®

Consumer Electronics Division

To: ATTENDEES

From: A. Leon

Subject: NEW SELF-CENTERING ANALOG CONTROLLER KICK OFF MEETING Date: 4/13/83

S. Upjohn of domestic marketing generated a summary Product Requirement Statement for 5100/5200 New Controller. This meeting was called to discuss engineering's position to design, develop the requested new controller within the limits specified by marketing.

The meeting started at 10:15 A.M. The attendees were:

C. Asher
A. Leon
B. Mizerek
D. Kramer
J. Jessep
M. Biasotti
A. DeSchweinitz
S. Upjohn

SUMMARY OF MEETING

1. Approaches

3 Approaches were identified.

A. With present tooling, aim for improved cost performance ratio.

B. With new design (new tooling) aim for low cost high reliability and high performance.

C. Total new radical design (pistal grip etc.....).

2. Cost

The cost limitation of $3.50 each is thought to be possible with approaches A and B. However, C. Asher felt the pistal grip will cost more than the $3.50/each limit.

Discussion on the cable cost indicated that cables made in U.S. costs around $3.00 each whereas cables made in Taiwan cost around $1.50.

3. Schedule

1. If the design requires new tooling, an estimated "production tool ready" time is = FEB 1984. This is not acceptable to Marketing.

2. A. DeSchweinitz will assist and look into internal soft tool capabilities.

Schedule (cont.)

3. If approach A is used, then target ship date of Dec. 1983 requested by marketing is possible.

4. Marketing Technical Requirements

In the course of design, marketing requests that engineering should look into the following:

1. More tacticle feed on the fire button.

2. No rubber boot.

3. Ergonomics as much as possible (human Engineering).

4. If time is available, investigate the following:

   a. gating alternatives.

   b. on/off self centering selection.

5. Frame design should be flexible to include future digital 3600.

5. Engineering Position

1. M. Biasotti and C. Asher have agreed to get together and generate an analysis of the 3 approaches identified in section 1. Analysis will include schedule, cost and what's involved.

2. This analysis will be distributed to the attendees on May 4, 1983.

3. Follow up meeting is scheduled for Friday May 6, 1983. A. Leon will sent out meeting notice.

The meeting adjourned at 11:15 A.M.

AL/lb

cc: K. Ashton
R. Nishi
D. Remson
G. Blondefield
B. Goldberg

PRODUCT REQUIREMENT STATEMENT

5200 CONTROLLER

GENERAL

NEW SELF-CENTERING
Name: ~~Low-Cost~~ 5200 Controller

Top Assy Number: TBD

Target Cost: Under $3.50 each (materials only) [REALISTIC, BUT ASSEMBLED IN HI-COST U.S.]

Target Ship Date: December, 1983 [FEB '84 FOR NU DESIGN]

MARKETING RATIONALE

Current controller presents the following problems:

-- low reliability (boots and fire buttons)

-- inadequate fire buttons

-- high cost

-- not enuff fun to play

TECHNICAL REQUIREMENTS

-- self-centering analog design*

-- compatible with all 5200 products

-- for hand-held use

-- no single source parts

→ -- increased tactile feedback on firebuttons*

? -- no rubber boot*

→ -- ergonomic redesign of fire buttons and controller housing

— selective on-off self-centering

ALFRED ASHPLOT "PATENTS IN PROGRESS"

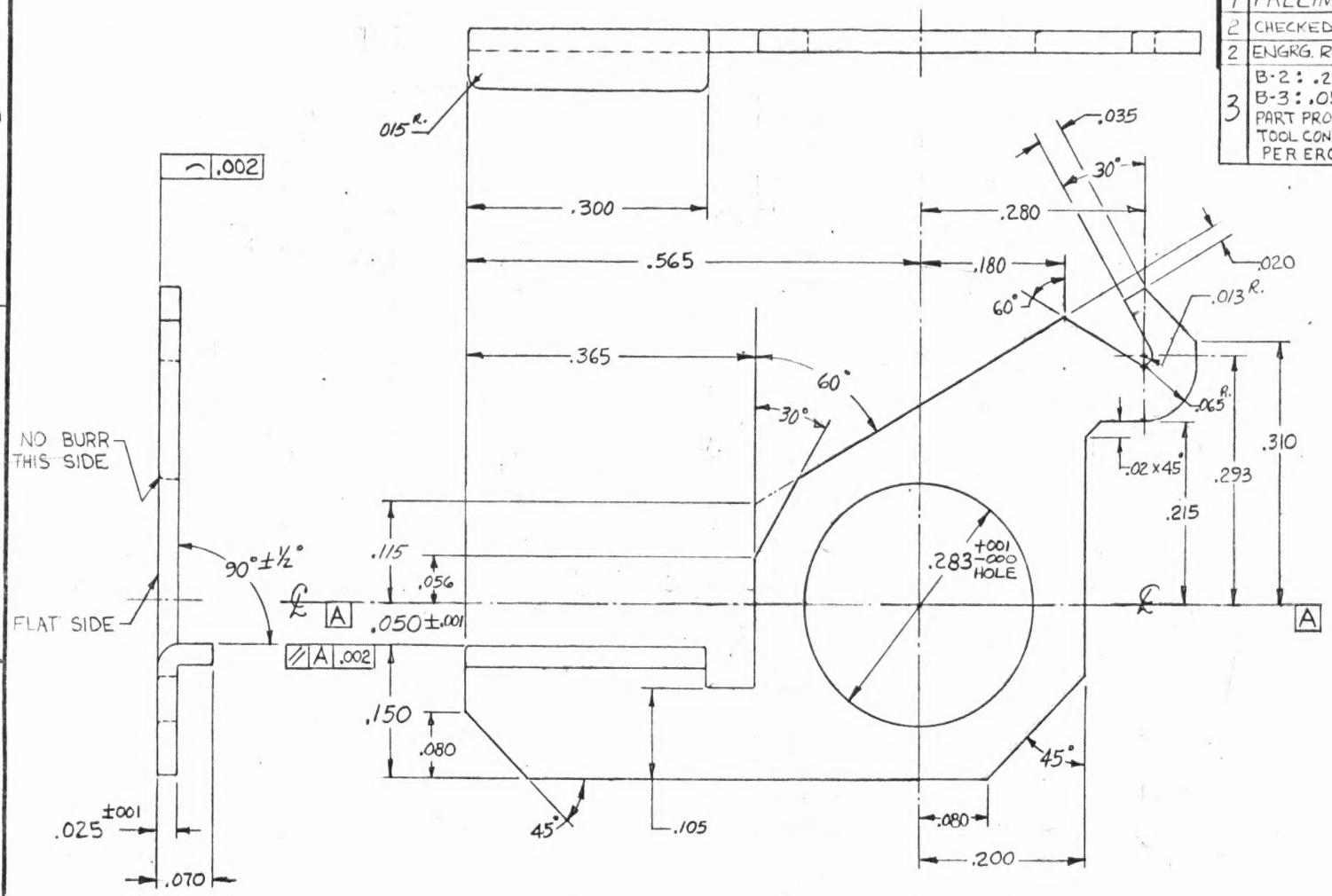
OTHER

-- investigate gating alternatives*

— '3600 digital-analog controllers'

NEW MTG FRI. MAY 6, 10:30
UPSTAIRS CONF. ROOM

SYM	REVISIONS DESCRIPTION	DATE	APPROVED
1	PRELIMINARY RELEASE	5/13/83	
2	CHECKED RELEASE	5/17/83	
2	ENGRG. REL, ERC # E0116A	10-10-83	
3	B-2 : .283 +.001 -.000 WAS .283 +.002 -.000 B-3 : .050 ± .001 WAS .050 ± .001 PART PROFILE CHANGED FOR EASIER TOOL CONSTRUCTION & MAINTAINENCE PER ERC E0174	7-13-83 7/18/83	



ENGINEERING RELEASED

CA022057	CX-52
NEXT ASSY	USED ON
APPLICATION	

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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
ANGLES = ±1°
SURFACE FINISH √ .x = ± .1 .xx = ± .01 .xxx = ± .005

MATERIAL: .025" C.R.S. (SOFT) TUMBLE DEBURR

FINISH: 50 MICRO/IN. ELECTROLESS NICKLE PLATE

DRAWN	J. Craig Asher	DATE 5-17-83
CHECKED	M. D. Allen	DATE 5-17-83
ENGINEER	J. Craig Asher	DATE 5-18-83
ENGINEERING MGR.	K. Allen	DATE 5-18-83
QUALITY ASSURANCE		DATE
MFG. ENGINEERING		DATE

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Sunnyvale, Calif. 94086
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TITLE: ARM, SELF CENTERING

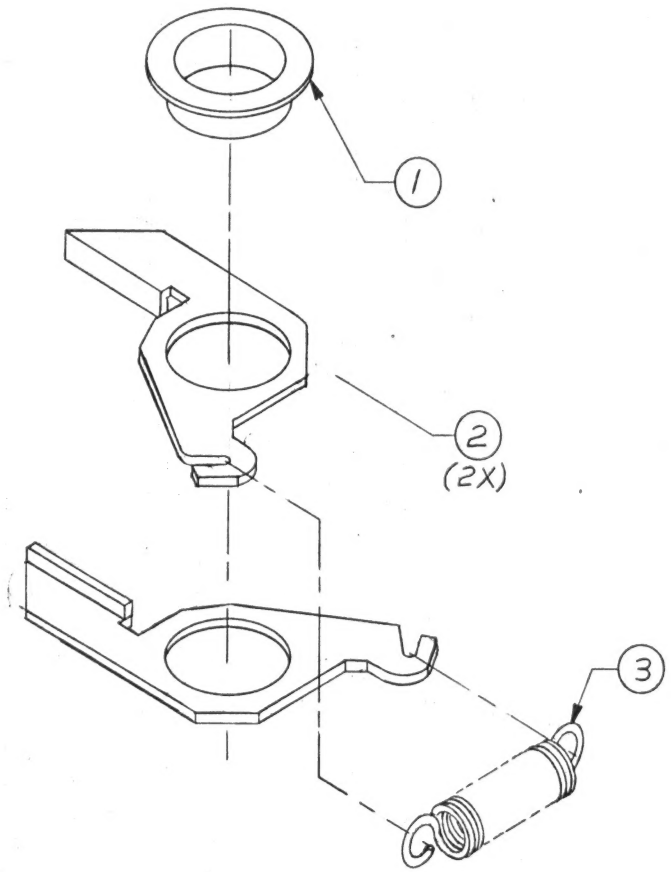
SIZE	DRAWING NO.	REV
C	C022058	3

SCALE 10 : 1 SHEET 1 OF 1

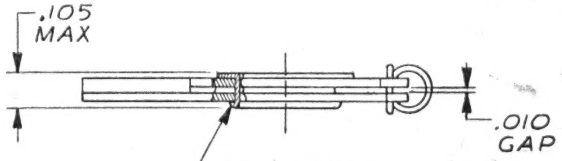
DRAWING NO. C022058 SHEET 1 REV 3

BISHOP GRAPHICS/ACCUPRESS REORDER NO. A15306

SYM	REVISIONS DESCRIPTION	DATE	APPROVED
1	ENGRG REL, ERC # E0116A	6-10-83	CAS
2	REV PER ERC E0174	7/18/83	TLR



ENGINEERING RELEASED



ASSY DETAIL
SCALE: 4X

ITEM	QTY	PART NUMBER	DESCRIPTION
3	1	C022060	SPRING, EXT
2	2	C022058	ARM, SELF CENTERING
1	1	C022059	BUSHING

CA018988	CX-52
NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
ANGLES = ±1°
.x = ±.1
.xx = ±.03
.xxx = ±.005
SURFACE FINISH ✓

MATERIAL:

FINISH:

		DATE
DRAWN BY	Don Folkerts	5/19/83
CHECKED	J. Clark	5-18-83
ENGINEER	Craig Asher	5-18-83
ENGINEERING MGR.	K Ashe	5-18-83
QUALITY ASSURANCE		
MFG. ENGINEERING		

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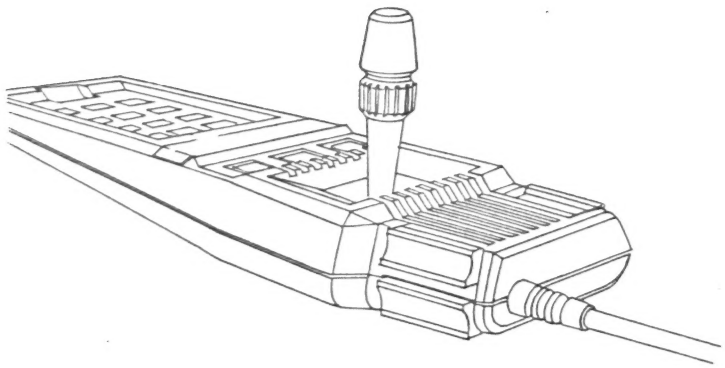
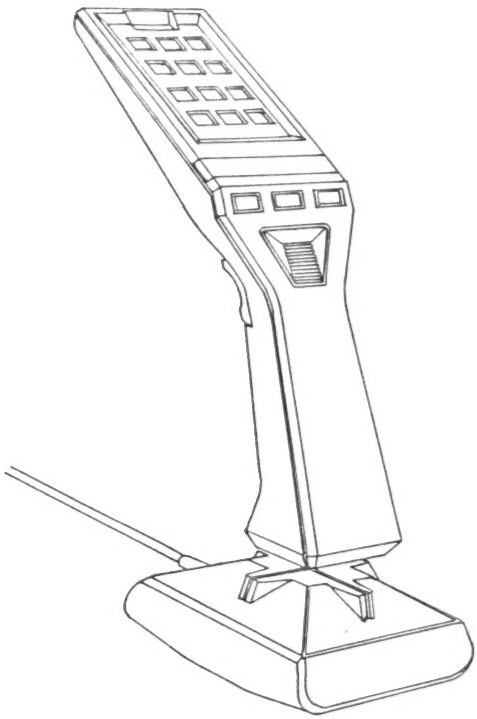
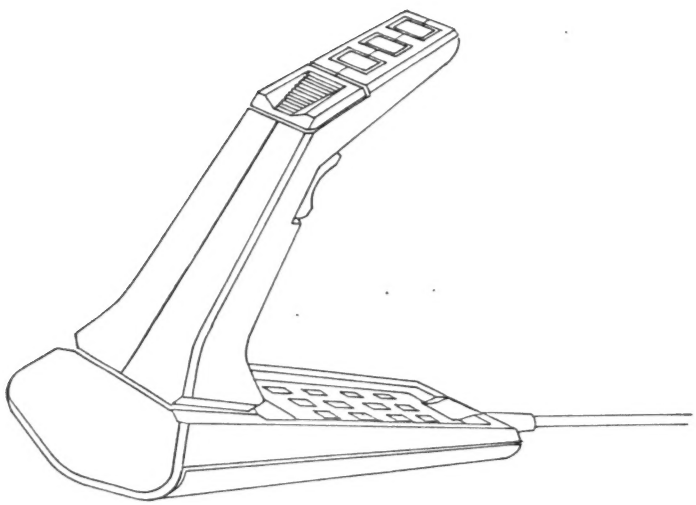
TITLE
SELF CENTERING
ARM ASSY

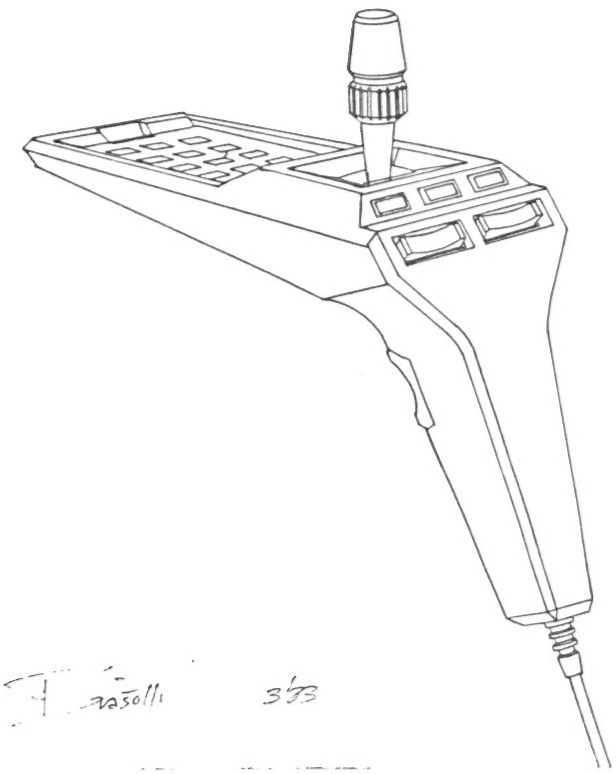
SIZE	DRAWING NO.	REV
C	CA022057	2
SCALE 4X	SHEET 1 OF 1	

DRAWING NO. CA022057 SHEET 1 REV 2

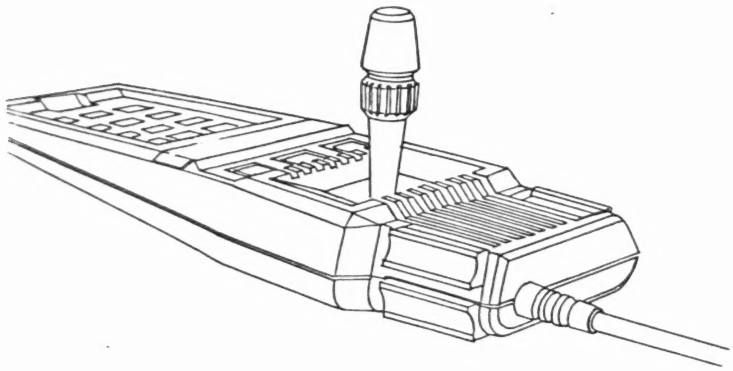








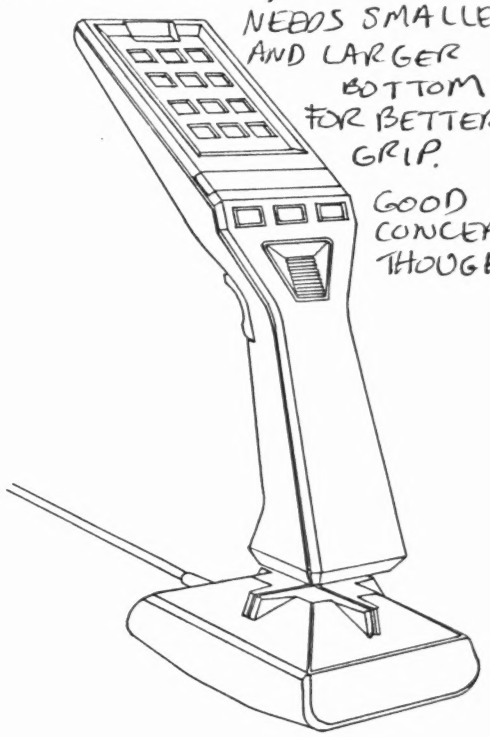
ASHER R. HASHER



MORE OF THE SAME, BUT FIRE BUTTONS BEING RECESSED COULD CAUSE MORE FATIGUE.

DIGITAL

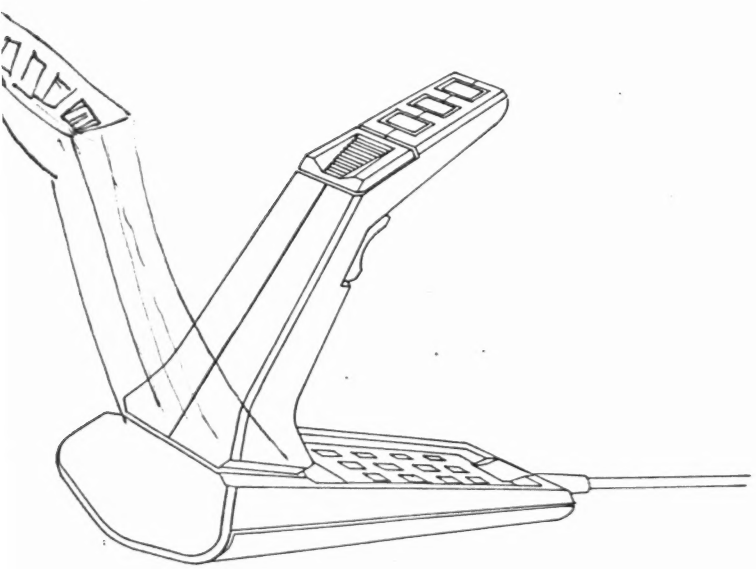
EXCESSIVE LEVERAGE, w/ TOO-SMALL BA



NEEDS SMALLER - AND LARGER BOTTOM FOR BETTER GRIP.

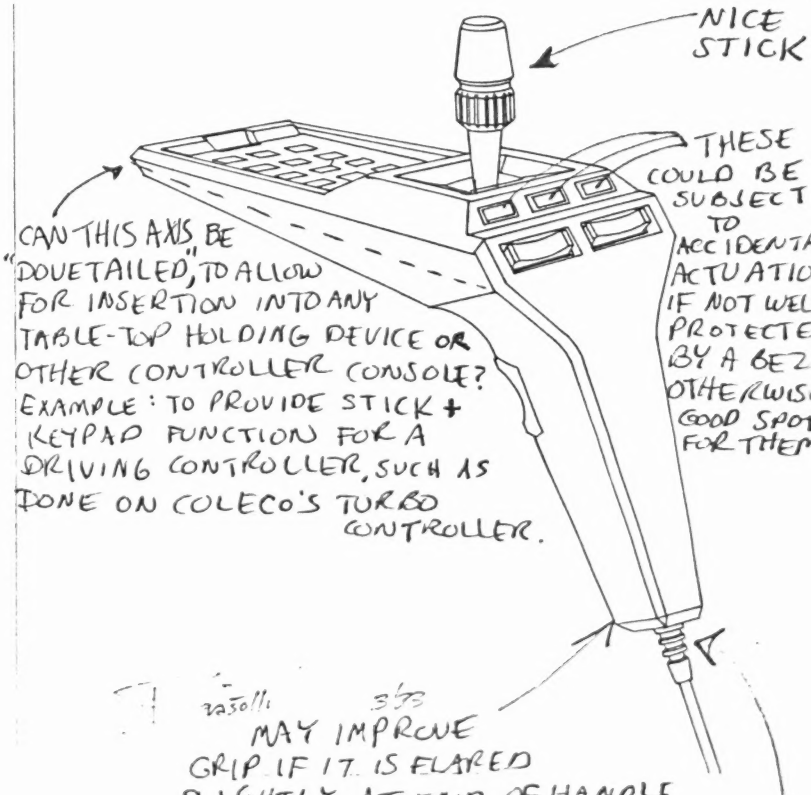
GOOD CONCEPT THOUGH!

MIXMASTER DEELUX



HANDLE SEEMS TO BE TURNED THE OPPOSITE DIRECTION FOR EASY COMFORT GRIP

ANALOG - YEAH!



NICE STICK

THESE COULD BE SUBJECT TO ACCIDENTA ACTUATIO IF NOT WEL PROTECTE BY A BEZ OTHERWIS GOOD SPO FOR THEM

CAN THIS AXIS BE "DOVETAILED" TO ALLOW FOR INSERTION INTO ANY TABLE-TOP HOLDING DEVICE OR OTHER CONTROLLER CONSOLE? EXAMPLE: TO PROVIDE STICK + KEYPAD FUNCTION FOR A DRIVING CONTROLLER, SUCH AS DONE ON COLECO'S TURBO CONTROLLER.

razoli 3/13

MAY IMPROVE GRIP IF IT IS FLARED SLIGHTLY AT END OF HANDLE

November 22, 1983

TO: Tom Kennedy

FROM: J.Jessop/E.Breeze/A.Tanaka

RE: 5200 ENHANCEMENTS/PRIORITIES

1. Hand Controllers
Present design needs thorough review.
a. Lower cost with easier manufacturability and servicability.
b. Reliabilty needs to be improved dramatically. Warranty repair cost is a major drain on the company.
c. Subjectively the game playability leaves a lot to be desired.
d. Preferrably a new design should be implemented to counter the negative consumer perception of the present design.

2. CONSOLE DESIGN
a. Reduce the cable clutter, i.e. pluggable power module, IR link, loop through antenna connection and power.
b. Front load console similar to front load VTR. This allows the unit to be stackable with other audio-visual equipment, so the customer will be deterred from storing the unit in closet/attic.

3. GAME ENHANCEMENTS
a. Integrate the 2600 game cartridge compatability and make the game ports adaptable for 2600 use.
b. With the 2600 compatibility, the unit can play advanced games as proposed for the TIA SQUARED project.
c. Investigate the feasibilty of using faster system clock to increase overall performance.
d. Improved expansion capability to accomodate video disk, optical ROM, and other periherals similar to COLECO.
e. Two player stereo headphone jack. Independent channel capability for the present and new generation games. This will allow the sounds and instructions to be audible to each player independent of each other. This has exciting possibilities for strategic action type games.
f. System power down feature to resume former play after interruption. Useful in long playtime games such as chess and adventure games.

CC: D. Teiser
C. Goy

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PROJECT TITLE: ANALOG CONTROLLER	MODEL NO:	DIST CODE: L

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* PRESS HARD – ORIGINATORS COPY LAST PAGE

1. ERC NUMBER: E0174

2. SHEET 1 OF 1

3. INITIATOR(PROJ. ENG.) / DATE	4. ENG. PROG. MGR. / DATE	5. INCORP/DATE	6. CHECK/DATE
CRAIG ASHER 7-12-83		NA 7/15/83	[illegible] 9/15/83

7. PROJECT NAME	8. PROJECT ACCT. NO.	9. MOD. AFFCTD.	10. OTHER MOD. AFFCTD.	11. DIST. CODE
ANALOG CONT	3V3014	CX52		L

12. PURPOSE INSERT FOR EACH DOCUMENT BELOW

D DOCUMENT CORRECTION
R DESIGN REQUIREMENT
C COST REDUCTION
E ENGINEERING RELEASE
I DESIGN IMPROVEMENT
M MANUFACTURING PROCESS
P PROCUREMENT
S CUSTOMER SERVICE

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AFFECTED DOCUMENTS					TOOLING		DISPOSITION						
DWG. NO.	PURP.	TITLE	REV IS	REV WAS	YES	NO	STOCK	ON ORDER	IN ASSY	IN UNITEST	FINAL TEST	FIELD	IN TECH PUBS
CA0[illegible]	I	ARM ASSY	2	1		X							
C023058	I	ARM	3	2	X								

BACKGROUND / REMARKS / DESCRIPTION OF CHANGE

U USE
S SCRAP
R REWORK
N NOT APPLICABLE

REDESIGN PART SHAPE FOR COST REDUCTION IN TOOLING AND FINISHED ASSEMBLY.

ERC NO. E0174

ENGINEERING RELEASED

PROJECT NAME	MODEL	PROJECT MANAGER
ANALOG CONTROLLER	CX5R	HANS KRAMER

PART NUMBER	REV.	DESCRIPTION	ECN NO.	DATE DISTRIBUTED
CA022057	2	ARM ASSY	80174	7/22/83
CD22058	3	ARM	↓	↓

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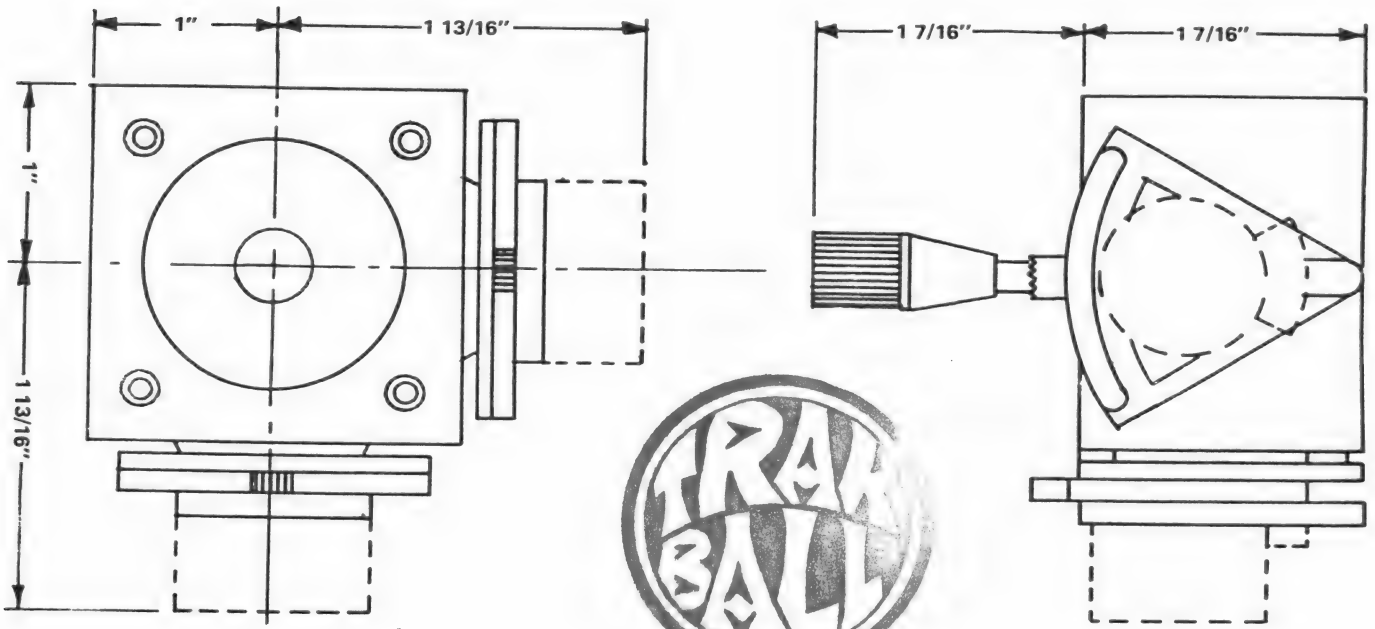
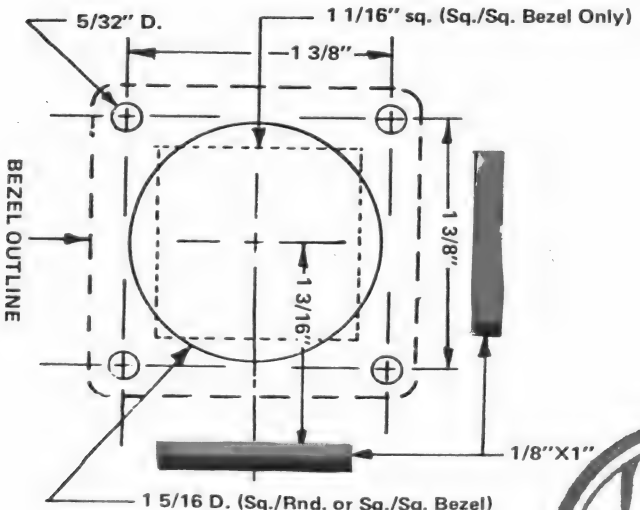
THE MKII CONTROL GIMBAL

DESCRIPTION

The MK II stick is a top quality, precision molded, two axis control gimbal intended for applications such as game joysticks, computer plotters, remote control transmitters and controllers, or any other uses requiring infinitely variable potententiometer settings in two axis. Both functions can be either self-centering or not and have a fine centering trim adjustment which is externally accessable. The trims don't have to exist if desired. Two styles of bezels are available; one with a square inner area, the other with a round inside.

The stick features quick assembly, smooth and accurate operation, very easy calibration, rugged design and long life. Also it is significantly less expensive than most alternatives that are available today.



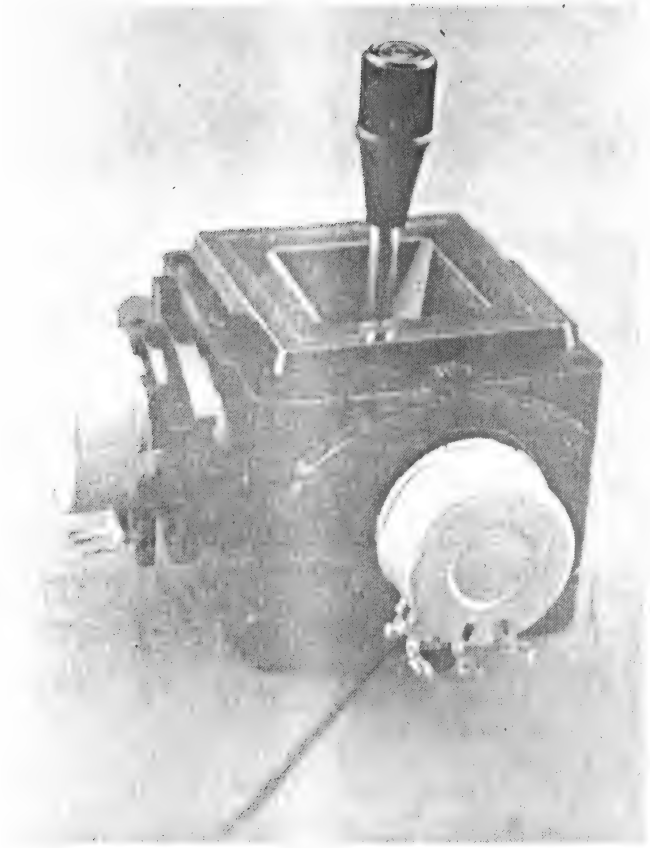


FACEPLATE CUTOUT REQUIREMENTS
(material thickness .050–.125")

POT SPECIFICATIONS

Any diameter pot with a 3/8-32 UNEF - 2A standard threaded bushing and a 1/4" X 3/8" shaft will work. The distance between the mounting face of the pot and the end of the shaft should be .812" ± .015".

ACE R/C, Inc.
BOX 511 116 W. 19TH ST. HIGGINSVILLE, MO. 64037



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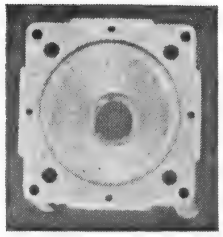
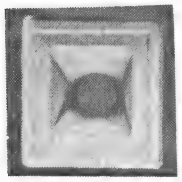
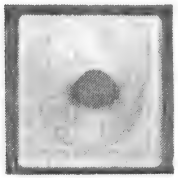


15E72—Front Housing Box

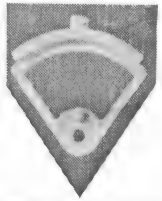


15E70—Square/Square Face Cup

(OR)



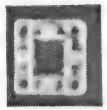
15E71—Square/Round Face Cup



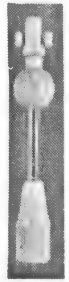
15E74—Trim Lever

(OR)

15E75—Trim Lever Substitute



15E78—Ball Retainer



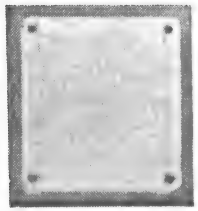
15E83—Stick/Ball Assembly

15E84—Spring Return Lever

15E94—Spring

15E93—Pot Nut

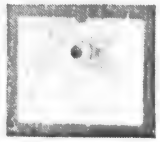
15E76—Friction Ring



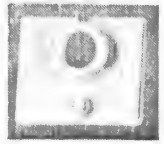
15E73—Gimbal Box Lid

15E81—Small Bale

15E82—Large Bale



15E80—Bale Retainer Side Plate



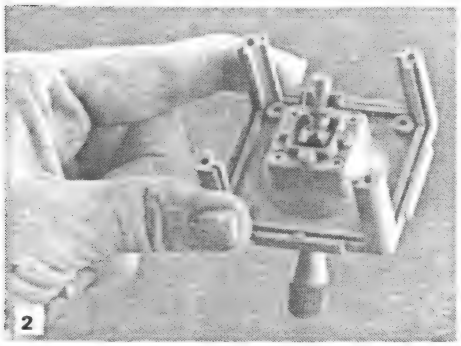
15E79—Pot Side Plate

15E77—Pot Lock Ring

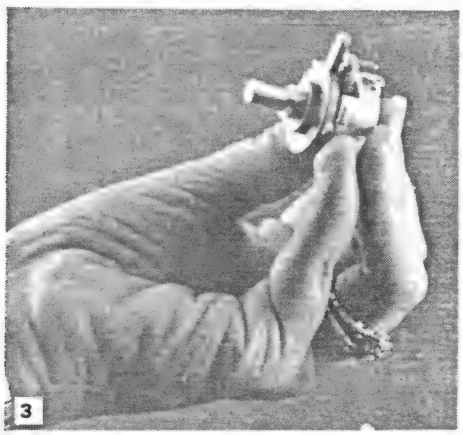
ACE MK II STICK ASSEMBLY

This is not step by step instructions, but a photo sequence to aid in assembly. The use of gray and black parts is for visual clarity.

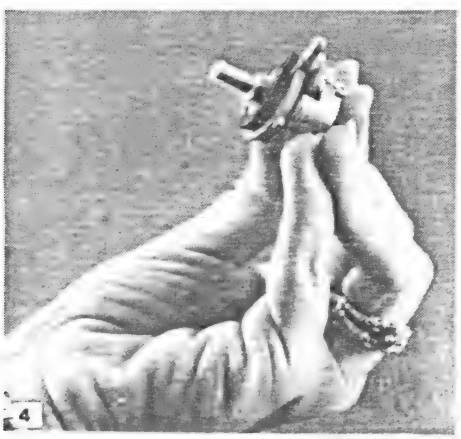
1—Insert Stick/Ball Assembly at an angle to clear Ball Retainer.



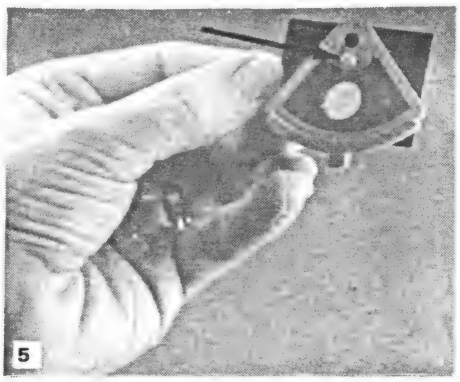
2—Tighten Ball Retainer screws until stick still moves when the Housing Box is jiggled.



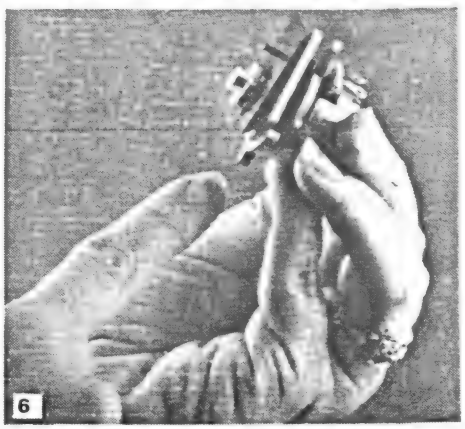
3—Note orientation of parts.



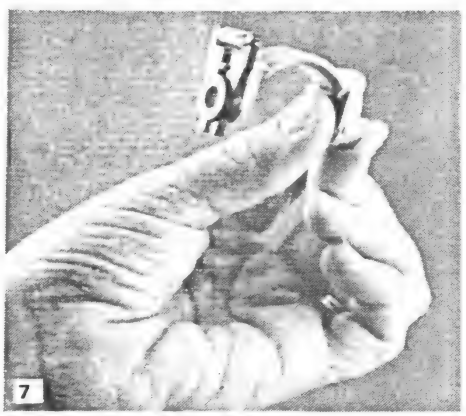
4—Make sure flat sides of Pot Lock Ring and Friction Ring are towards pot.



5—Button, on Trim Lever, faces out to engage mating hole in Friction Ring. NOTE If Trim Levers are not used, insert Trim Lever Substitute.

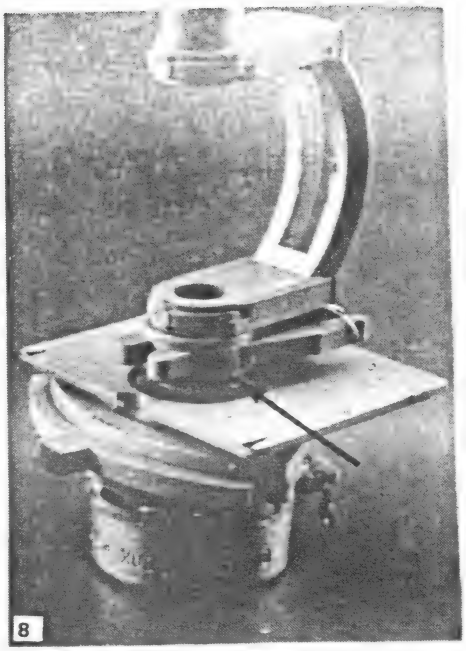


6—Center Trim Lever.

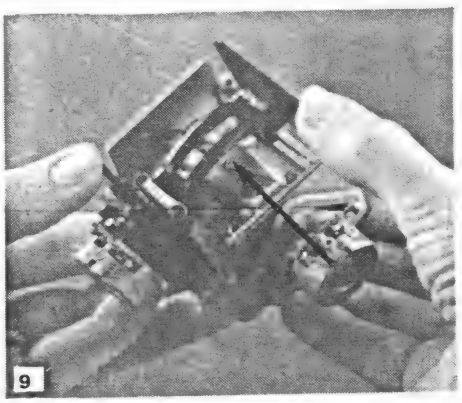


7—Spring Return Levers and Spring are centered on Bale.

ACE R/C, Inc.
BOX 511 HIGGINSVILLE, MO. 64037 816 584-7121

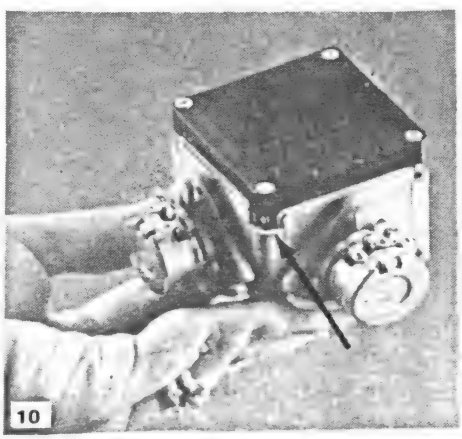


8 -There must be .005" to .007" clearance between Spring Return Levers and Pot Nut.



9 —Install Small Bale Assembly, then Large Bale Assembly into Housing Box. Make sure Stick end piece goes through each Bale.

NOTE: Before the Gimbal Box Lid can be put on the Face Cup and assembled Gimbal must be fastened to panel using four 2-56 x 1/4" pan head screws.



10—Install Gimbal Box Lid with four 2-56 x 1/2" F.H. screws. Allow .010" gap at corner posts.

ATARI® ENGINEERING LOG SHEET

11/29/82

GAME OR PROJECT
Spectravision Joystick Analysis

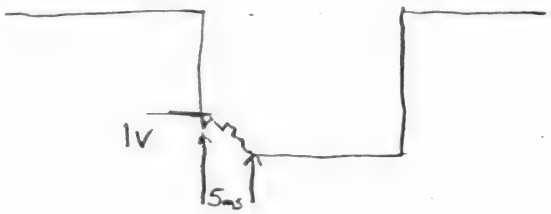
Spectravision Joystick Model 318-101

Electrical:

Resistance = Ω

1) Contact Resistance
   A) Pin 1 = UP Postion 5Ω to 80 Ω
   B) Pin 2 = Down Position 15Ω to 98 Ω
   C) Pin 3 = left Postion 7Ω to 40 Ω
   D) Pin 4 = Right Postion 5Ω to 38 Ω

2) Contact Bounce measeared at fire Button was found to be 1v for 5ms



3) P.C.B Consisted of one Board with contact switches mounted on it.

4) Assembly was quite easy as well as disassembly

Game Application

1) Human Engineering should be given 90%
2) Ease of Actuation is a 80% due to the lack of Centering Ability
3) Direct UP-DN-Rt-Lt motion is a 95%
4) Diagonal motion is a 75% Has a tendency to want to go Rt or Up
5) fire button is compable to Atari

*** Over All due to the Human Engineering Concepts I would have to Rate this Joystick a 80%

WRITER	DATE	WITNESS	DATE
Chris Smith	11/29/82		

SUBJECT: A PIEZOCERAMIC BENDER CONTORLLER

A piezoceramic bender controller could be produced using a square shaft with piezoceramic wafers laminate on all four sides. The direction would be detected by the voltage change of the two wafers on oppisite sides of the shaft for each axis. If a third axis was needed for a product a curved piezocermic bender could be used which would be controlled by squeezing either a trigger button or sqeezing the grip.

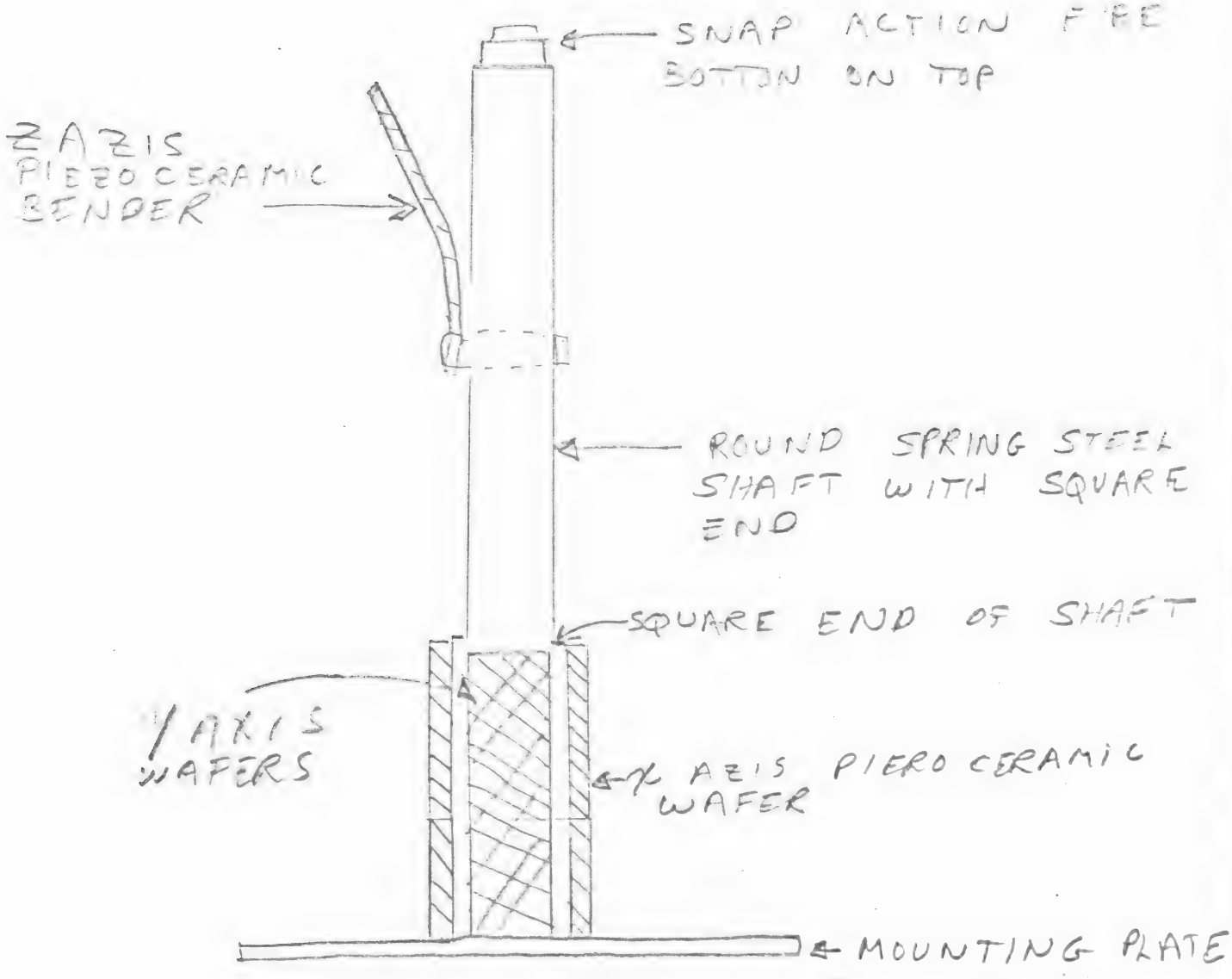
The controller would have very few moving parts. Spring steel would need to be used for the shafts. The controller could be design to be very tough due to the mat'l required and the lack of moving parts required. The controller by design would have a automatic return to center by the fact that the shaft is spring steel.

The cost of the piezo and shaft should be low when compare to other systems used now. The shaft maybe could be made out of aluminum for lower cost and less weight if aluminum could be found with the right spring.

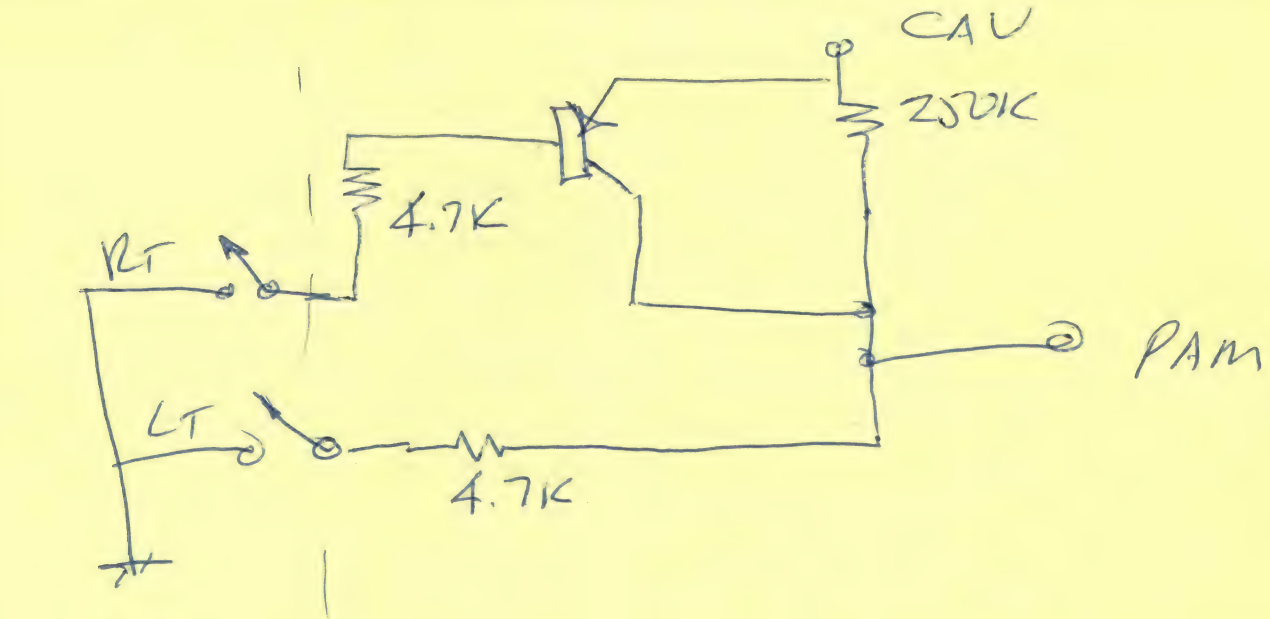
The firm of PIERO ELECTRIC PRODUCTS,INC of Cambridge Mass., Porter Stone : President, should be ready to lend a hand in design and production of a wafer-shaft compont.

Thank You

Rolan Denis Estrada



R D ESTRADA 8/14/02

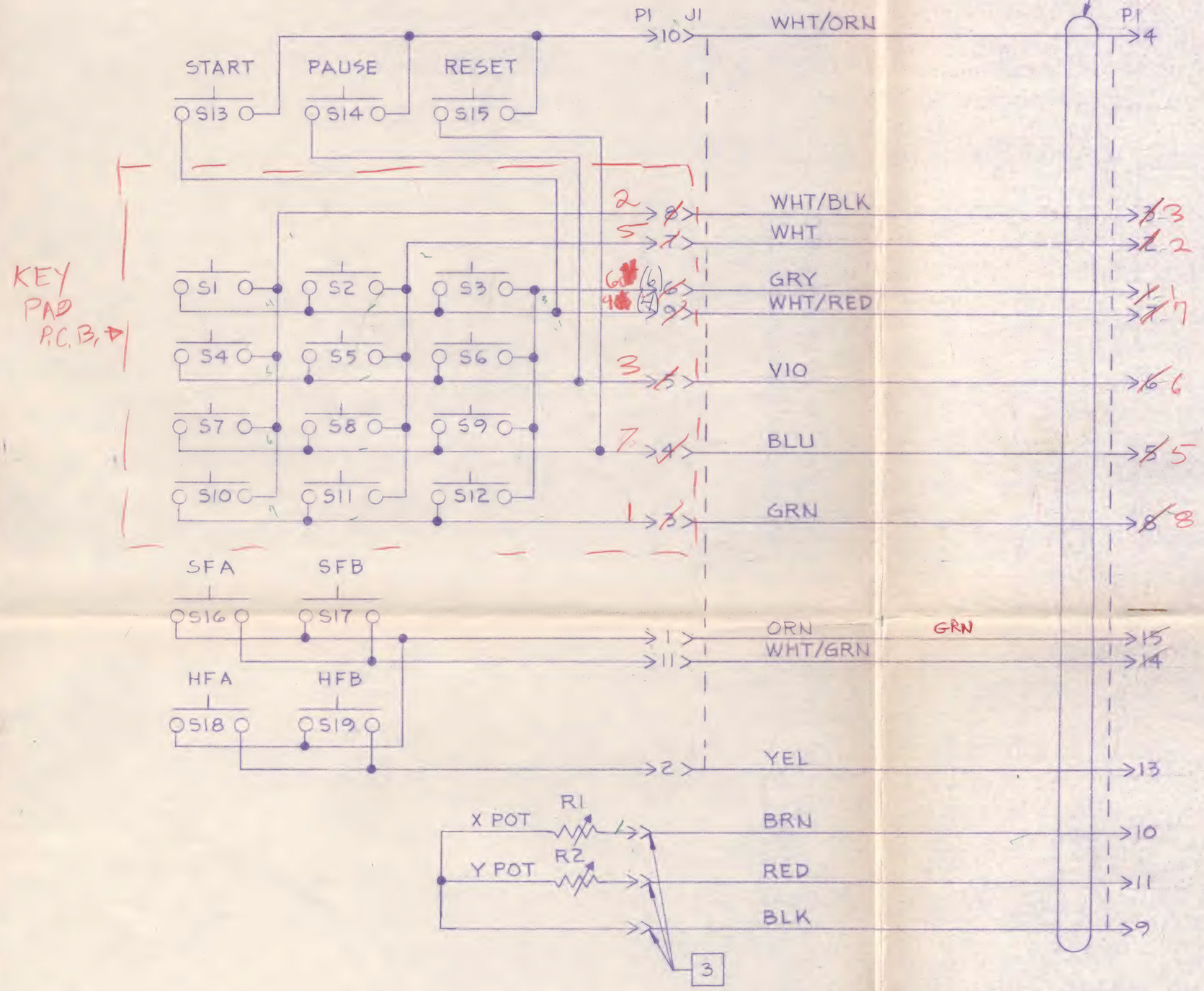


STOCK
STICK -
TO PAM
ADAPTER

SYM	REVISIONS DESCRIPTION	DATE	APPROVED
1	RELEASED	3/29/82	

PC C018124

CABLE ASSY CAO 18145



NOTES:

1. FOR ASSEMBLY SEE CAO18107.
2. UNLESS OTHERWISE SPECIFIED: SYMBOLS ARE PER ANSI STANDARDS
3. SLIDE CONNECTORS.

JUL 13 1982
LATEST REVISION

OUTSTANDING ECNs	

CA018107	CX52
NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
ANGLES = ±1°
.X = ±
.XX = ±
.XXX = ±
SURFACE FINISH ✓

MATERIAL:

FINISH:

DO NOT SCALE DRAWING

DRAWN BY FALKAR DATE 12/4/81

CHECKED

ENGINEER Pete Grant 3/26/82

PROJECT ENGINEER 3/26/82

MFG ENGINEER

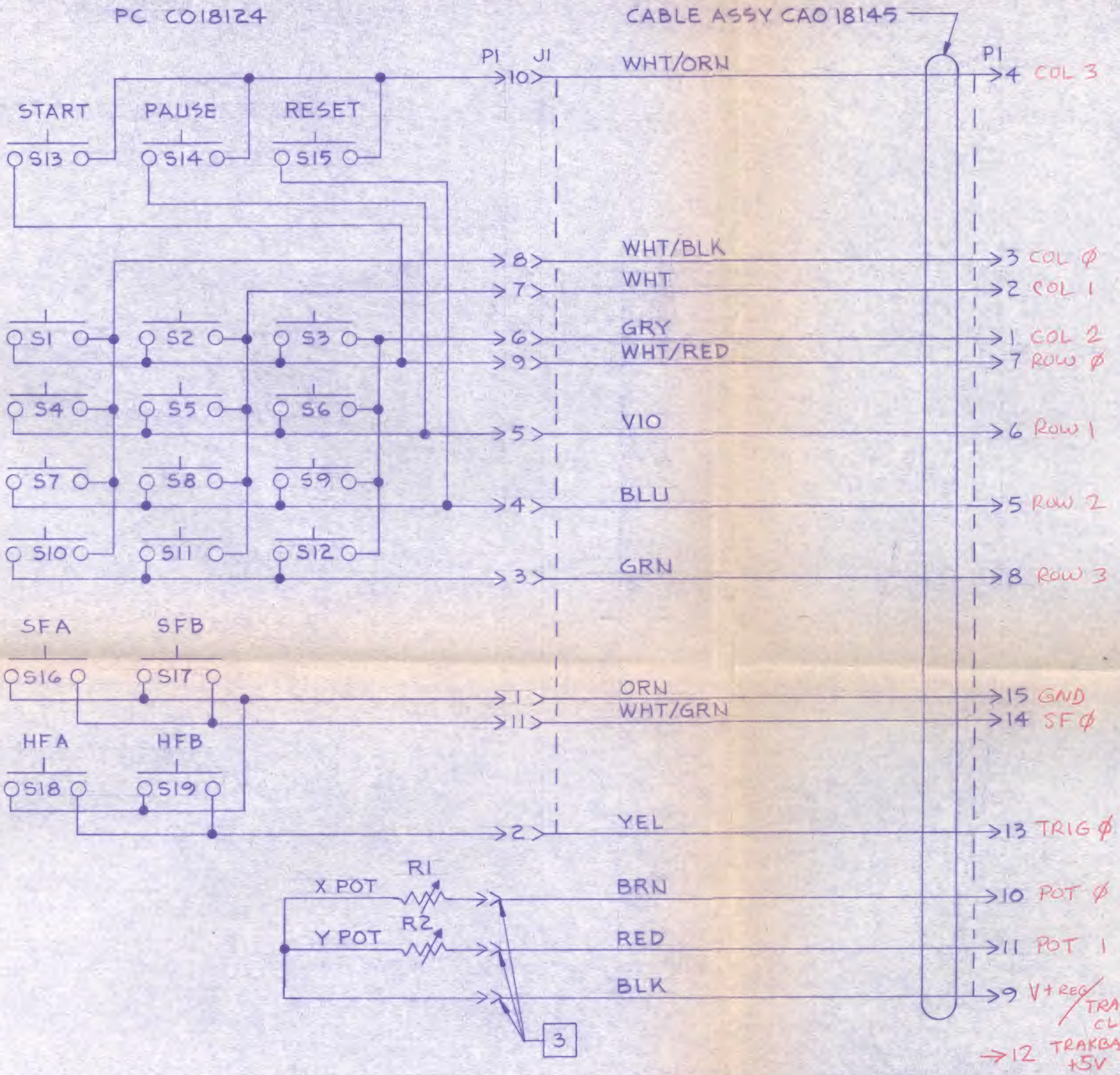
ATARI®
Atari, Inc.
1272 Borregas Avenue
Sunnyvale, Calif. 94086
A Warner Communications Company

TITLE
SCHEMATIC DIAGRAM, CONTROLLER
RAM CON

SIZE	DRAWING NO.	REV
C	C018226	1

SCALE — SHEET 1 OF 1

SYM	REVISIONS DESCRIPTION	DATE	APPROVED
1	RELEASED	3/29/82	



NOTES:

1. FOR ASSEMBLY SEE CA018107.
2. UNLESS OTHERWISE SPECIFIED: SYMBOLS ARE PER ANSI STANDARDS
3. SLIDE CONNECTORS.

OUTSTANDING ECNs	

CA018107	CX5200
NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON:
ANGLES = ±1°
SURFACE FINISH √ .X = ± .XX = ± .XXX = ±

MATERIAL:

FINISH:

DO NOT SCALE DRAWING

DRAWN BY FALKAR DATE 12/4/81

CHECKED

ENGINEER Peter Brand 3/26/82

PROJECT ENGINEER 3/26/82

MFG ENGINEER

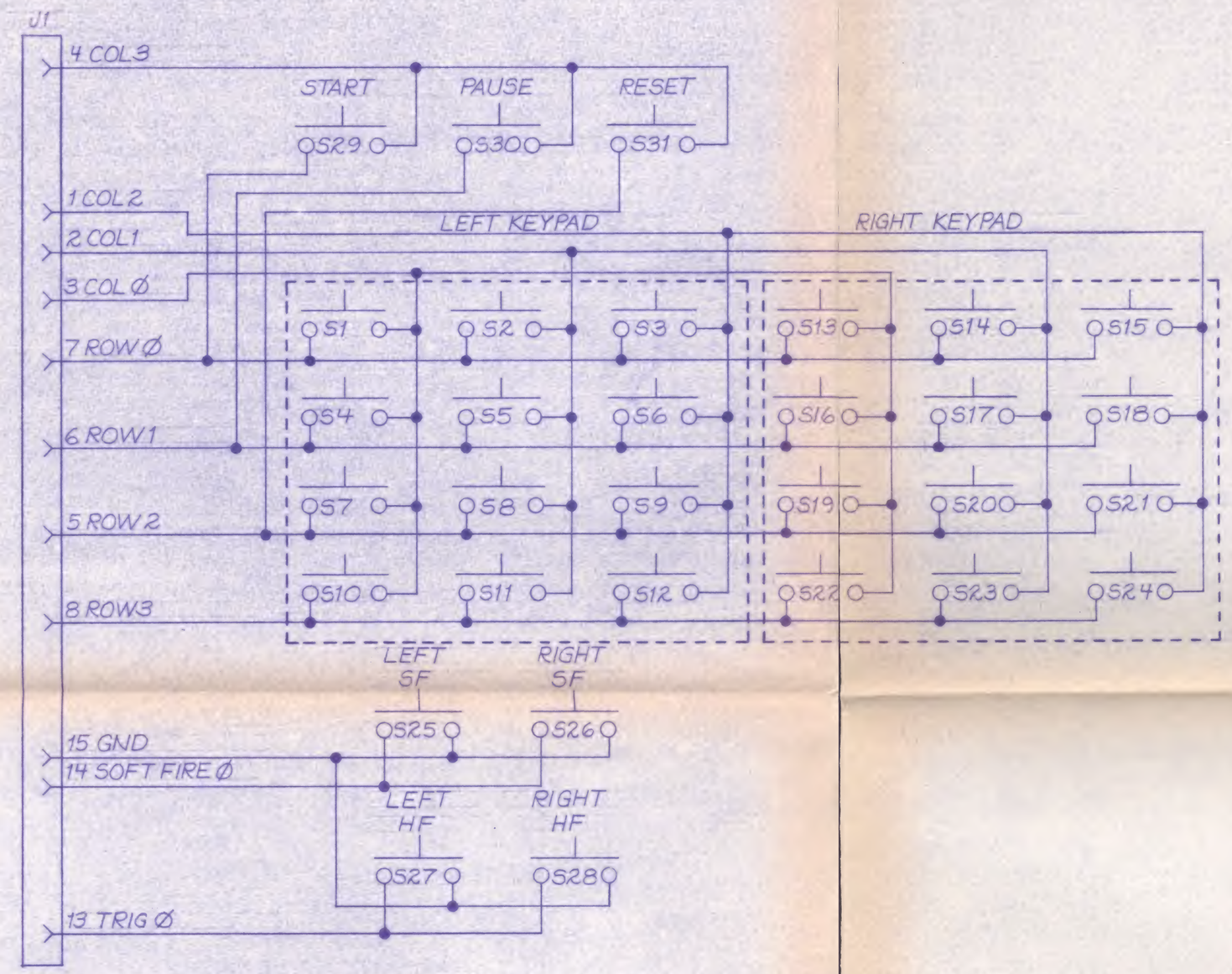
ATARI®
Atari, Inc.
1272 Borregas Avenue
Sunnyvale, Calif. 94086
A Warner Communications Company

TITLE: SCHEMATIC DIAGRAM, CONTROLLER

SIZE	DRAWING NO.	REV
C	C018226	1
SCALE —	SHEET 1 OF 1	

DRAWING NO. C018226 SHEET 1 REV 1

SYM	REVISIONS DESCRIPTION	DATE	APPROVED
1	RELEASED		



NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL COMPONENTS ARE AS MARKED

LAST USED	NOT USED
J1	
~~S24~~ S31	

DRAWING NO CA020286 | SHEET 1 | REV 1

CA020197	CX53
NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
ANGLES = ±1°
SURFACE FINISH ✓
.x = ± .1
.xx = ± .03
.xxx = ± .005

MATERIAL:

FINISH:

DRAWN BY 10-6-82 SR.DEL VECCHIO	DATE	
CHECKED	DATE	
ENGINEER	DATE	
ENGINEERING MGR.	DATE	
QUALITY ASSURANCE	DATE	
MFG. ENGINEERING	DATE	

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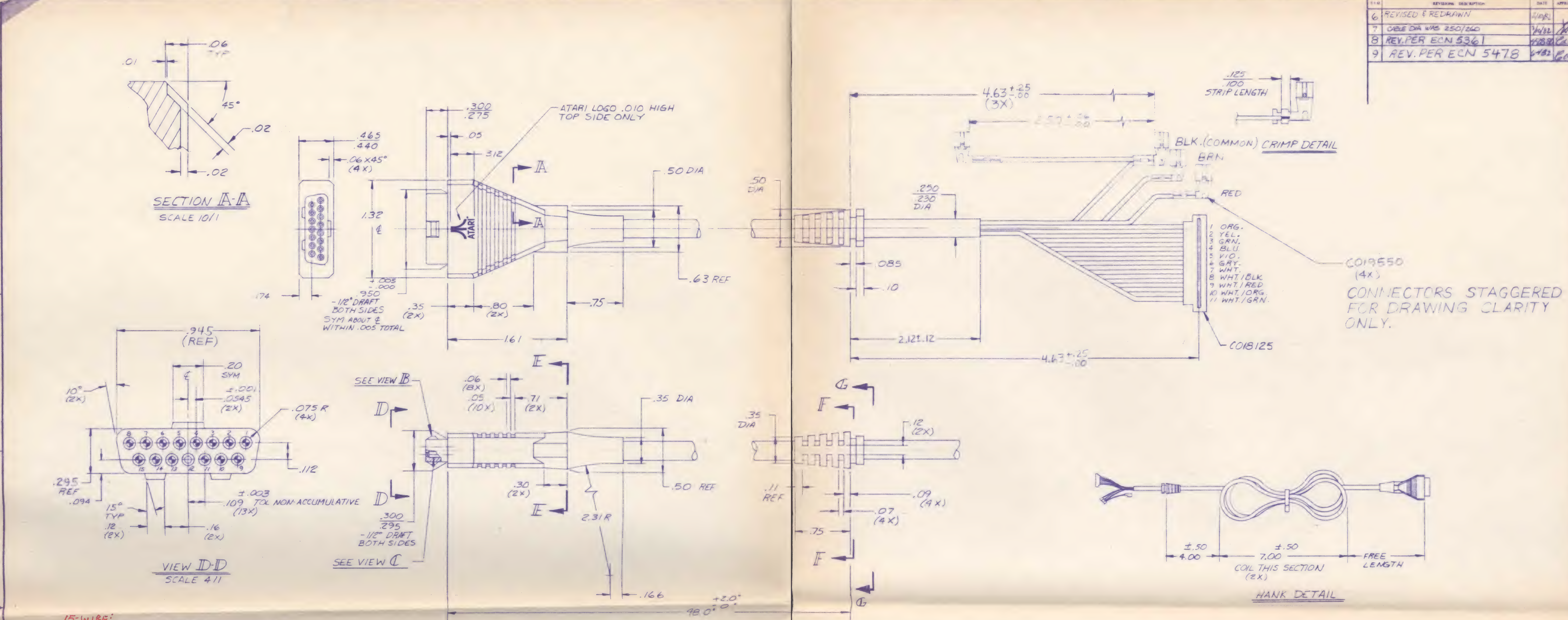
Sunnyvale, Calif. 94086
A Warner Communications Company

TITLE
CX53 KEYBOARD SCHEMATIC (UPPER)

SIZE	DRAWING NO	REV
C	CA020286	1

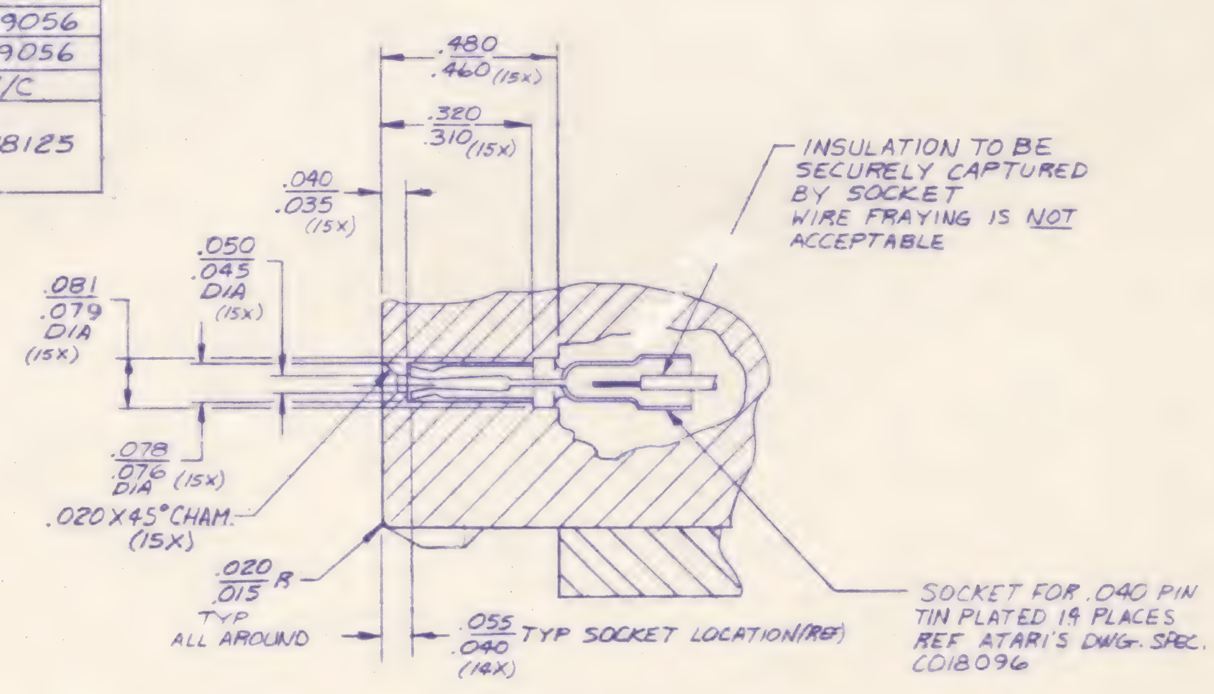
SCALE NONE SHEET 1 OF 1



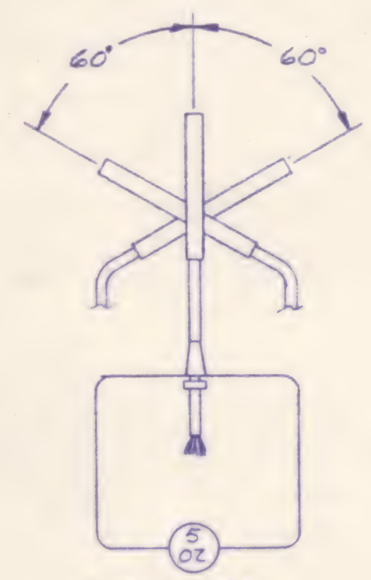
REVISIONS
6 REVISED & REDRAWN
7 CABLE DIA WAS .250/.260 3/4/82
8 REV. PER ECN 5361
9 REV. PER ECN 5478
SECTION A-A
SCALE 10/1
ATARI LOGO .010 HIGH TOP SIDE ONLY
.50 DIA
.63 REF
-1/2° DRAFT BOTH SIDES SYM ABOUT ℄ WITHIN .005 TOTAL
STRIP LENGTH
BLK. (COMMON) CRIMP DETAIL
BRN.
RED
1 ORG.
2 YEL.
3 GRN.
4 BLU.
5 VIO.
6 GRY.
7 WHT.
8 WHT./BLK.
9 WHT./RED
10 WHT./ORG.
11 WHT./GRN.
C019550 (4X)
CONNECTORS STAGGERED FOR DRAWING CLARITY ONLY.
C018125
VIEW D-D
SCALE 4/1
.109 TOL NON-ACCUMULATIVE (13X)
SEE VIEW B
SEE VIEW C
.35 DIA
.50 REF
98.0
COIL THIS SECTION (2X)
FREE LENGTH
HANK DETAIL

15-WIRE:

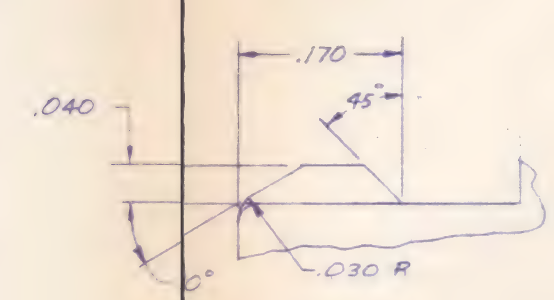
CONNECTOR COLOR CODE		
PIN	WIRE COLOR	ATARI PART NO.
1	GRY.	C018125
2	WHT.	
3	WHT. /BLK.	
4	WHT. /ORG.	
5	BLU.	
6	VIO.	
7	WHT. /RED	
8	GRN.	
9	BLK.	C019056
10	BRN.	C019056
11	RED	C019056
12	N/C (WHT/BRN)	N/C
13	YEL.	C018125
14	WHT. /GRN. (WHT/YEL)	
15	ORG.	



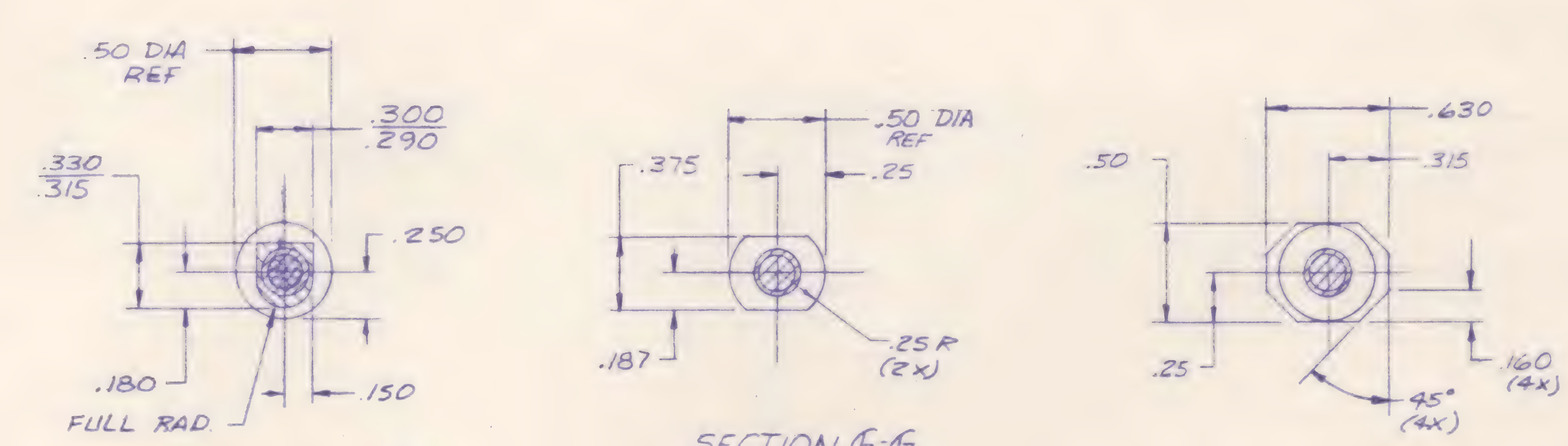
DETAIL C
SCALE NONE
TYPICAL 14 PLACES



DETAIL H
SCALE NONE



VIEW B
SCALE 10/1
TYPICAL 3 PLACES



SECTION F-F
SCALE 2/1

SECTION G-G
SCALE 2/1

SECTION E-E
SCALE 2/1

SEE SHEETS 2&3 FOR APPLICABLE NOTES AND SPECS.
NOTE: * SH 2 & 3 ARE 'A' SIZE

OUTSTANDING ECNs

NEXT ASSY	USED ON
CA018988	CX5200

APPLICATION

MATERIAL: SEE NOTES SH 2

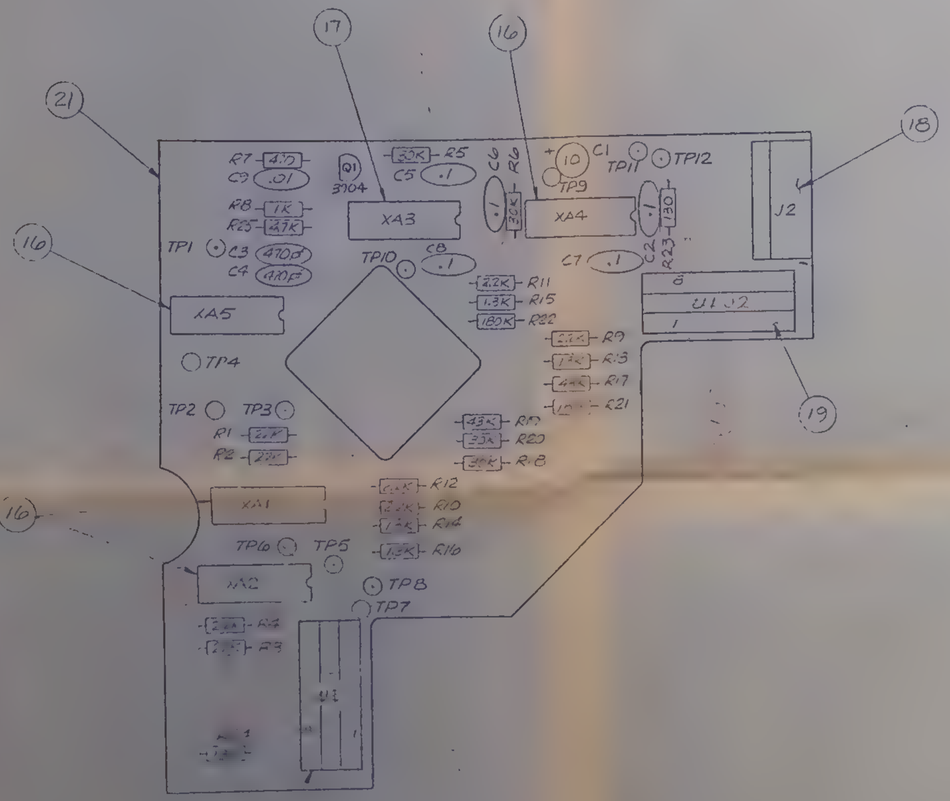
FINISH: SEE NOTES SH 2

DO NOT SCALE DRAWING

Atari, Inc. 1265 Borregas Avenue Sunnyvale, Calif. 94086

TITLE: CONTROLLER CABLE ASSEMBLY 14 CONDUCTOR MOLDED

SIZE E — DRAWING NO. CA018145 — REV 9



NOTES UNLESS OTHERWISE SPECIFIED

1. ALL RESISTOR VALUES ARE IN OHMS, 1/4W 5%.
2. ALL CAPACITORS ARE IN uF.

REVISED FOR LATEST CHANGES

LATEST REVISION

LAST USED	NEXT USE
C9	
R25	
XA5	
U2	
J2	J1
Q1	
XA5	

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1272 Borregas Avenue
Sunnyvale Calif 94086

ATARI

CPSB TERMINAL
PCB SCHEMATIC

D

B

NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTOR VALUES ARE IN OHMS, 1/4W 5%.

2. ALL CAPACITORS ARE IN μF.

A


17
16
21
18
16
R7 470
C9 .01
Q1
3904
30K R5
C5 .1
C6 .1
R6 30K
+ 10 C1
TP9
TP11
TP12
R8 1K
R25 4.7K
XA3
XA4
.1
130
J2
TP1
C3 470pf
C4 470pf
TP10
C8 .1
C7 .1
C2 .1
R23 1M
8
U1
U2
1
XA5
2.2K R11
1.3K R15
180K R22
TP4
2.2K R9
1.3K R13
43K R17
18K R21
TP2
TP3
R1 22K
R2 22K
43K R19
30K R20
30K R18
REAR
19
XA1
2.2K R12
2.2K R10
1.3K R14
1.3K R16
16
TP6
TP5
XA2
TP8
TP7
22K R4
22K R3
U2
8
1
R24
130
19

REVISED FOR LATEST CHANGES

DK 11/22/82

B

LAST USED	NOT USED
C9	
R25	
A5	
U2	
J2	J1
Q1	
XA5	

NOV 11 1982

LATEST REVISION

SHEET 1 IS "A" SIZE PARTS LIST

CA020140	CX53
NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
ANGLES = ±1°
.X = ± .1
.XX = ± .03
.XXX = ± .005
SURFACE FINISH ✓

MATERIAL.

FINISH:

	DATE
DRAWN BY J. Hooper	10/6/82
CHECKED	
ENGINEER	
ENGINEERING MGR	
QUALITY ASSURANCE	
MFG. ENGINEERING	

ATARI

Atari, Inc.
1272 Borregas Avenue
Sunnyvale, Calif. 94086

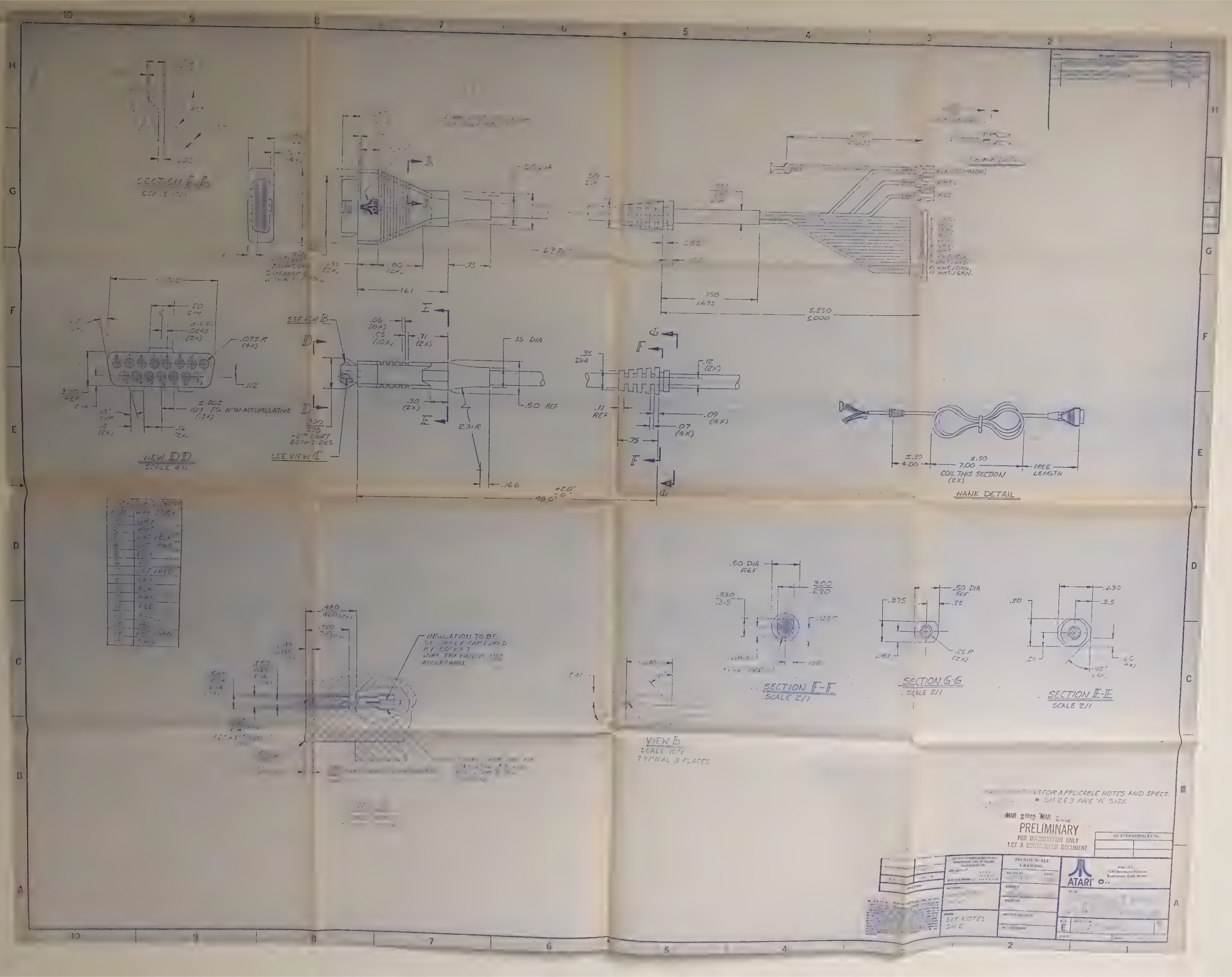
TITLE
CX53 TRAKBALL
P.C.B SUB-ASS'Y
(LOWER)

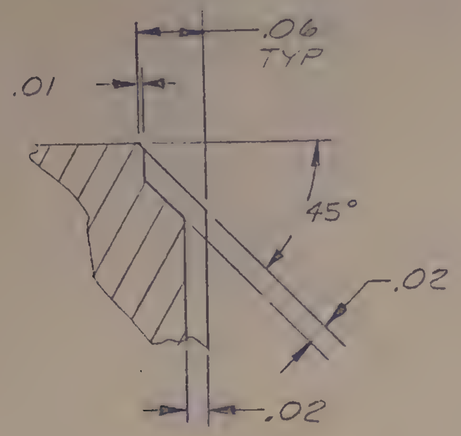
SIZE	DRAWING NO	REV
D	CA020141	1

SCALE 2X SHEET 2 OF 2

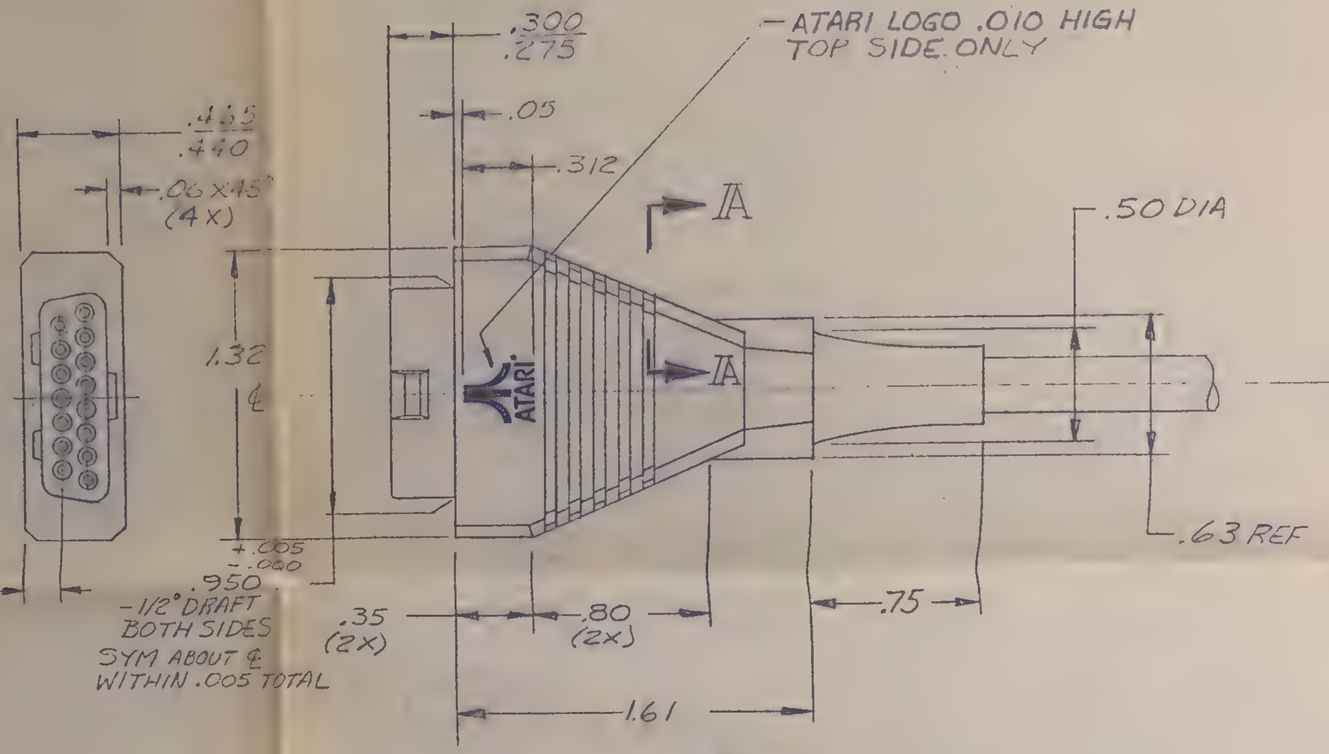
A

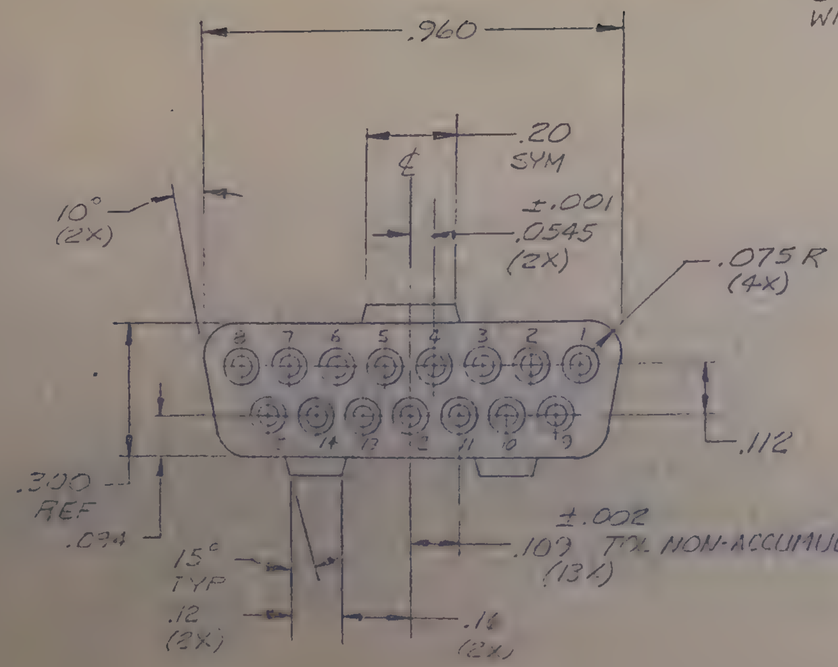
1 3 2 1


SECTION E-E
SCALE 2/1
SECTION F-F
SCALE 2/1
SECTION G-G
SCALE 2/1
VIEW D-D
SCALE 4/1
VIEW B
TYPICAL 3 PLACES
SEE VIEW B
SEE VIEW C
HANK DETAIL
COIL THIS SECTION
(2X)
FREE LENGTH
NON-ACCUMULATIVE
INSULATION TO BE
35 DIA
.50 REF
.50 DIA
REF
2.31 R
.166
48.0
+2.0
5.250
5.000
.750
1.695
.161
.80
(2X)
.75
.30
(2X)
.075 R
(4X)
.112
.09
(4X)
.07
(4X)
.11
REF
.12
(2X)
.35
DIA
.71
(2X)
.06
(6X)
.05
(10X)
7.00
±.50
±.50
4.00
.630
.375
.300
.290
.330
.315
.25 R
(2X)
45°
(4X)
10 WHT./ORG.
11 WHT./GRN.
FOR APPLICABLE NOTES AND SPECS.
SH 2 & 3 ARE 'A' SIZE
PRELIMINARY
FOR INFORMATION ONLY
NOT A CONTROLLED DOCUMENT
DO NOT SCALE DRAWING
ATARI
SEE NOTES
SH 2
E

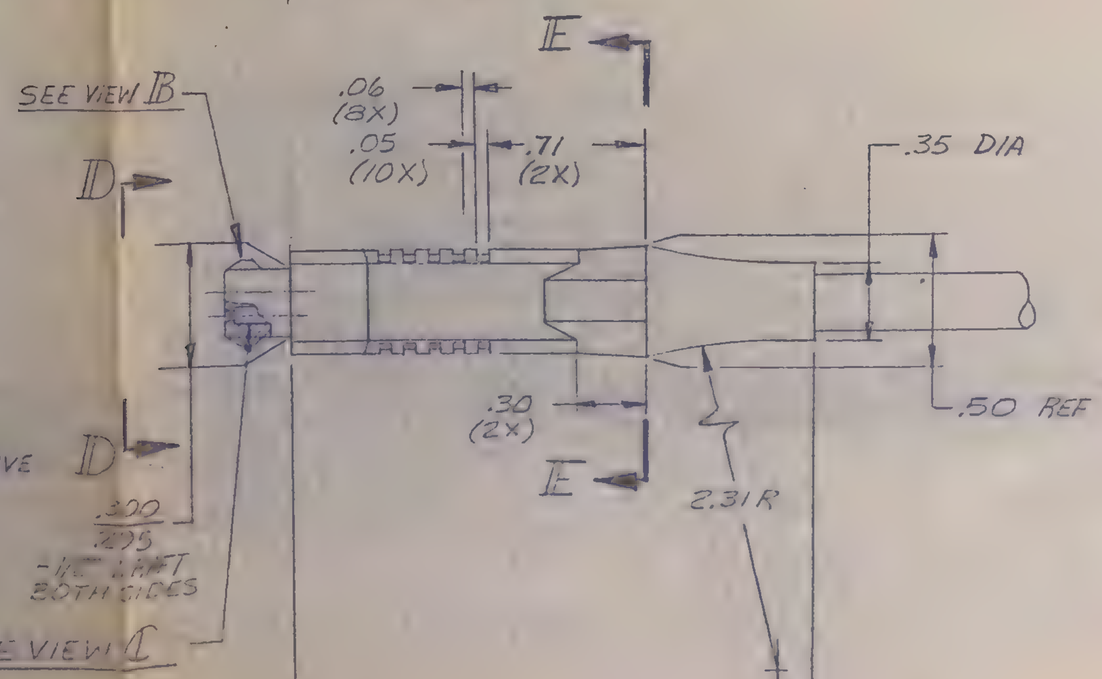


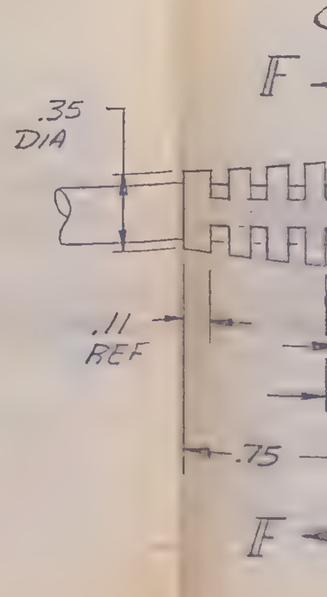
SECTION A-A
SCALE 10/1





VIEW D-D
SCALE 4/1





SYM	REVISIONS DESCRIPTION	DATE	APPD
6	REVISED & REDRAWN		AC
7	CABLE DIA WAS .250/.230		AC

.125
.100
STRIP LENGTH

2.750
2.695

CRIMP DETAIL

BLK. (COMMON)
BRN.
RED

1 ORG.
2 YEL.
3 GRN.
4 BLU.
5 VIO.
6 GRY.
7 WHT.
8 WHT./BLK
9 WHT./RED
10 WHT./ORG.
11 WHT./GRN.

.250
.230
DIA

.085
.100

1.750
1.695

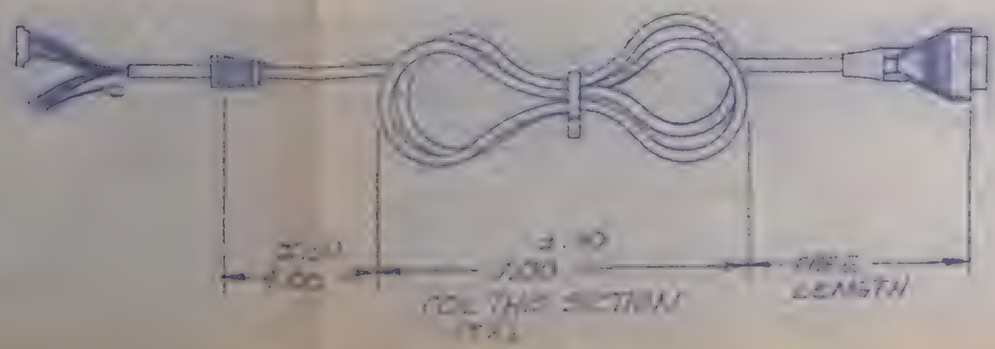
5.250
5.000

.12
(2X)

.11
REF

.07
(4X)

.15

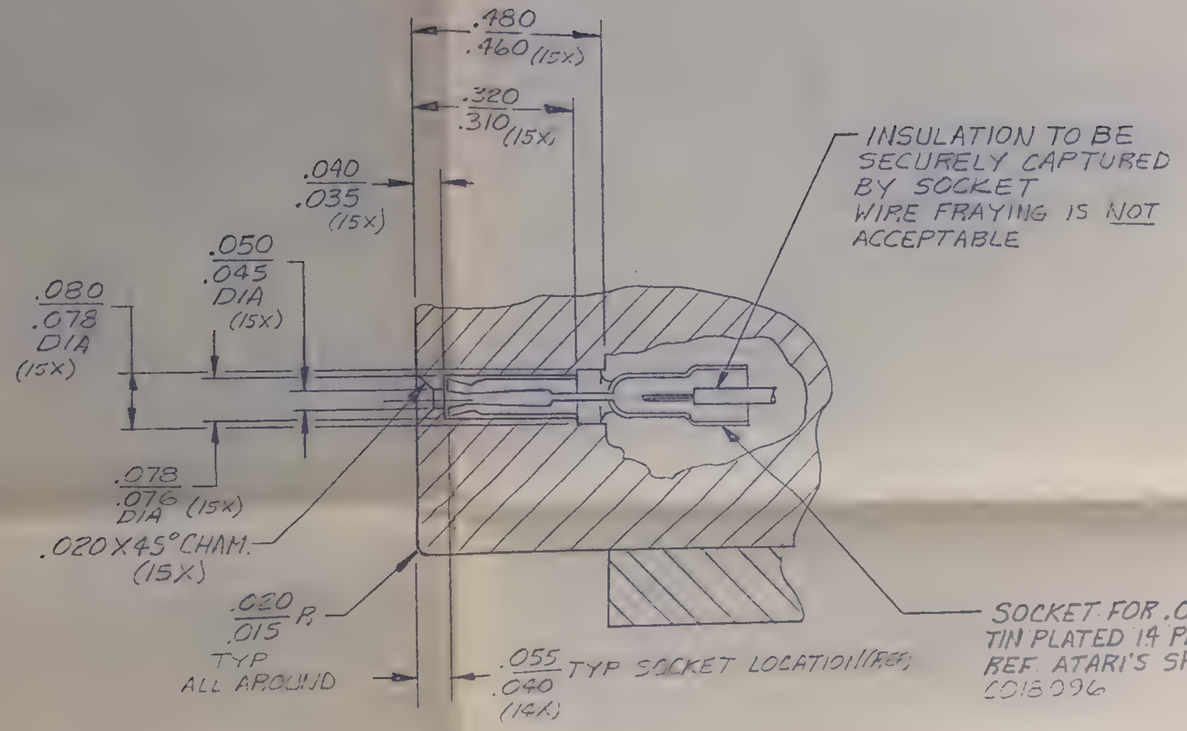


HANK DETAIL

DRAWING NO. CA01845
SHEET 1
REV 7

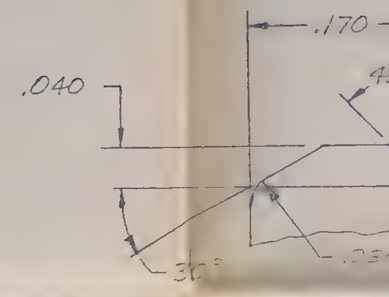
SCALE 4/1

CONNECTOR COLOR CODE	
PIN	WIRE COLOR
1	GRY.
2	WHT.
3	WHT. /BLK.
4	WHT. /ORG.
5	BLU.
6	VIO.
7	WHT. /RED
8	GRN.
9	BLK.
10	BRN.
11	RED.
12	N/C
13	YEL.
14	WHT. /GRN.
15	ORG.



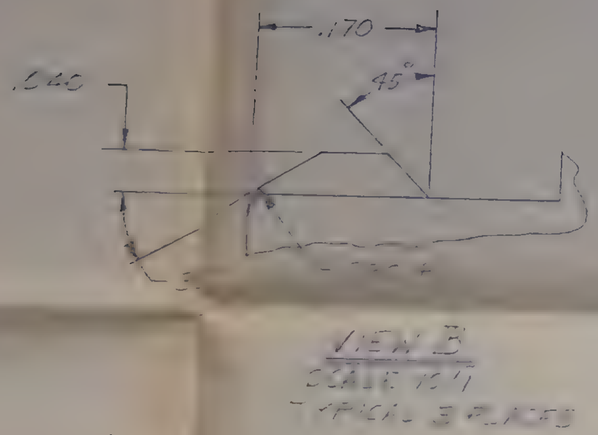
DETAIL C

SCALE NONE
TYPICAL 14 PLACES

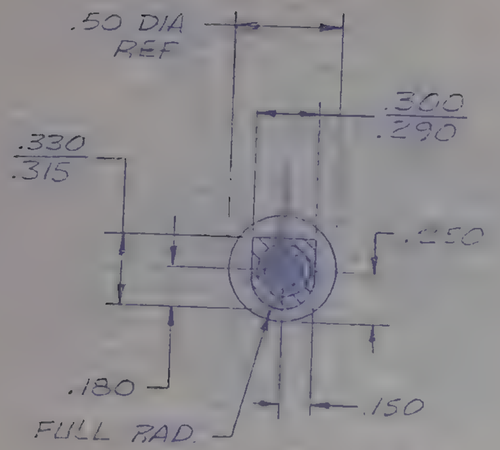


VIE
SCAL
TYPIC

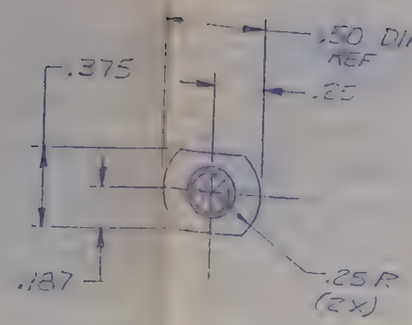
10 9 8 7 6



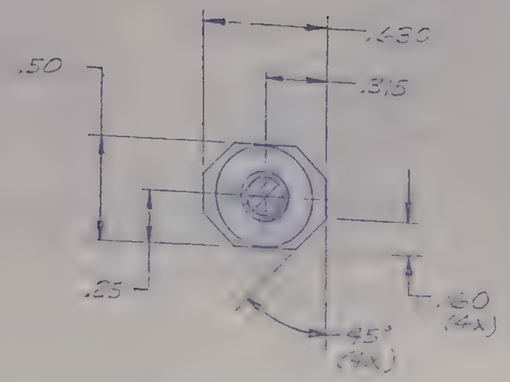
VIEW B
SCALE 10/1
TYPICAL 3 PLACES



SECTION F-F
SCALE 2/1



SECTION G-G
SCALE 2/1



SECTION E-E
SCALE 2/1

SEE SHEETS 2&3 FOR APPLICABLE NOTES AND SPECS.

NOTE: * SH 2&3 ARE 'A' SIZE

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OUTSTANDING ECNs	

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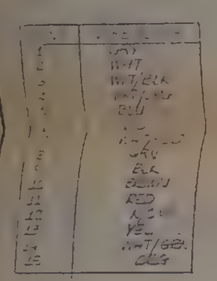

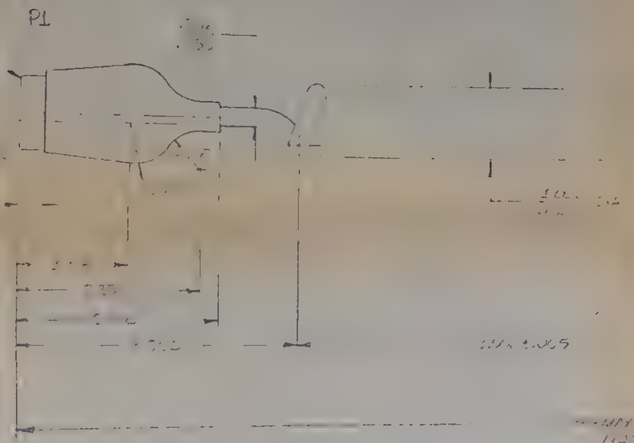

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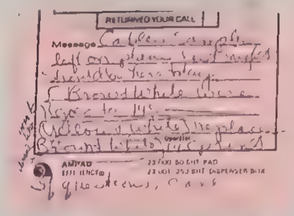

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TITLE

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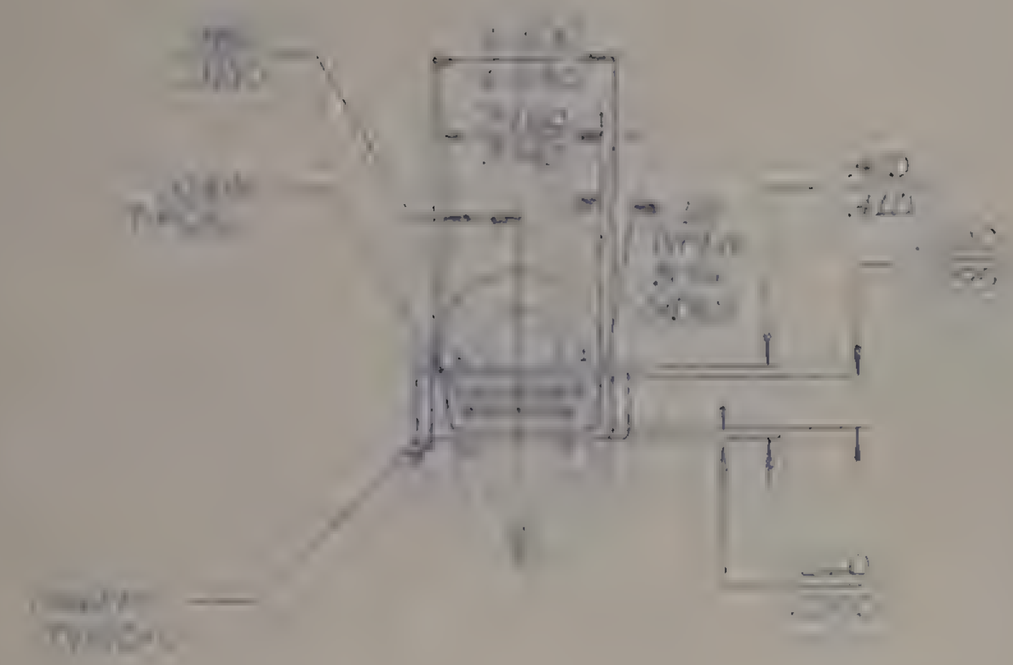

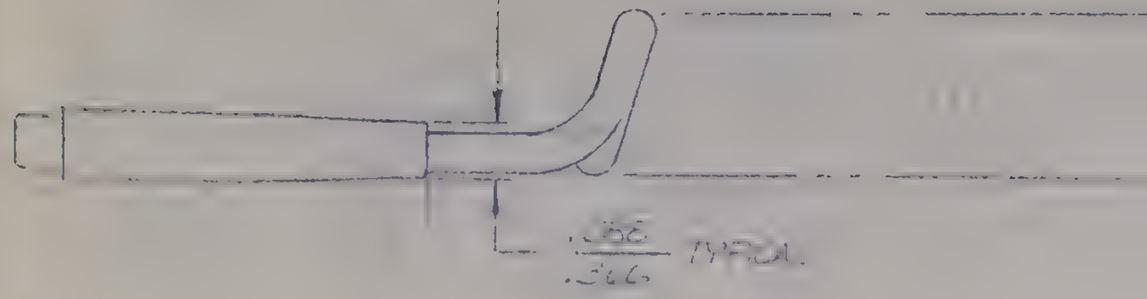

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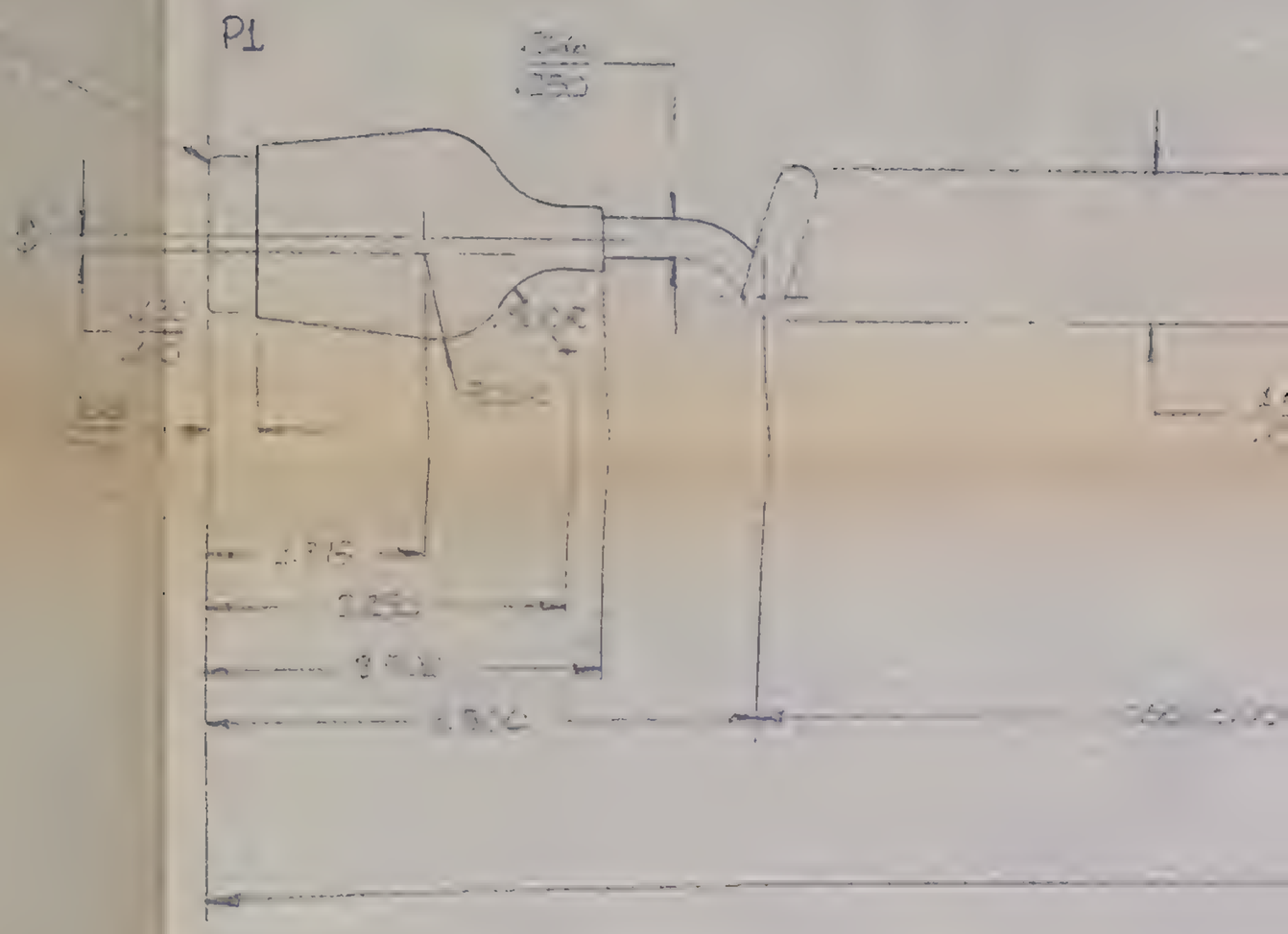

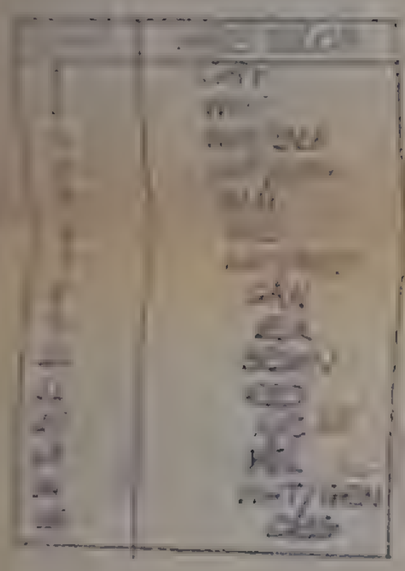

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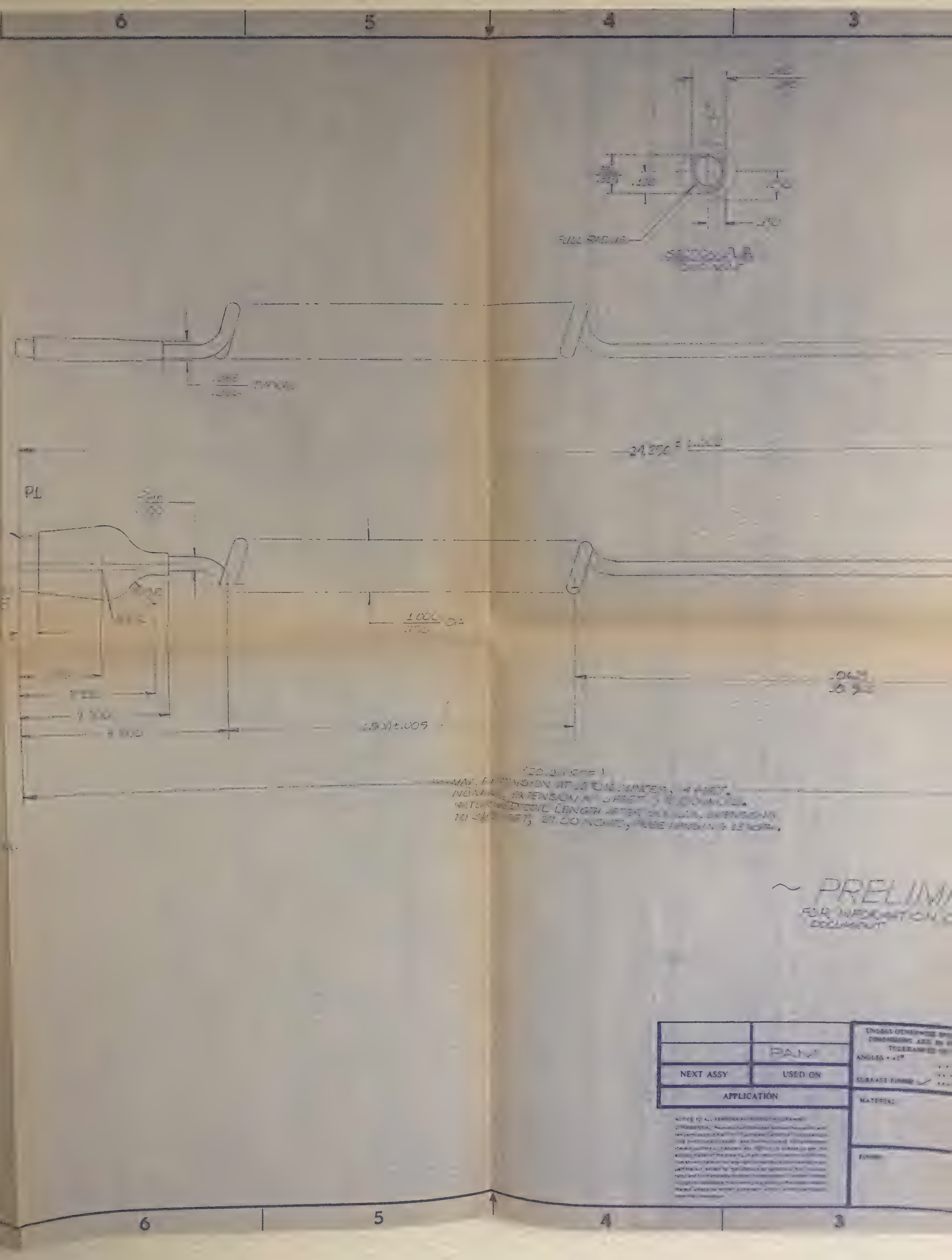
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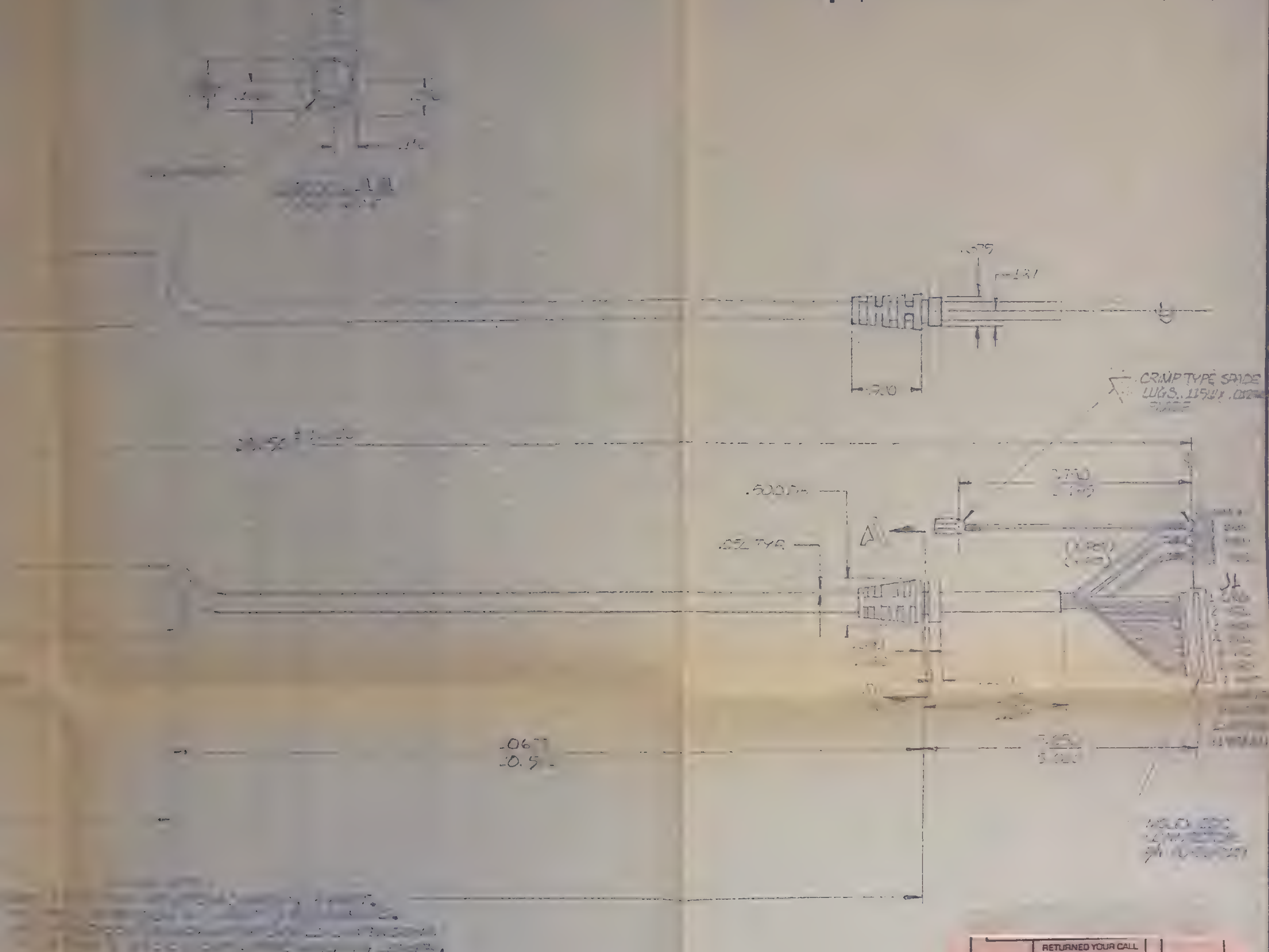

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TITLE: CONTROLLER CABLE ASSEMBLY

SIZE D — DRAWING NO — REV 3

SCALE NONE — SHEET 1 OF 1


KYNAR™
Piezo
Film
A unique, flexible polymer film
with high piezo and pyroelectric activity.
PENWALT
CHEMICALS ▪ EQUIPMENT
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KYNAR™ Piezo Film—A versatile new transducer material

Piezoelectric materials, which transform a mechanical force to an electrical response and conversely, transform an electrical signal to a mechanical motion, have been known for many years. Examples are highly polar natural crystals and ceramics such as quartz and barium titanate, respectively. These materials are dense, brittle, stiff and difficult to produce in large sizes and impractical to fabricate into complex shapes. Recently, polymeric piezoelectric films have been developed. They are pliant, flexible, tough and lightweight. Of all known polymers, those based on vinylidene fluoride show the highest piezo- and pyroelectric activities. Polyvinylidene fluoride, PVDF, is the base resin used in the development of KYNAR Piezo Film by the Pennwalt Corporation. This specialty film is now available in various thicknesses for application as transducers for many industrial devices.

Molecular structure

Polyvinylidene fluoride, PVDF, is a semi-crystalline high molecular weight polymer of repeat unit (CH_2-CF_2) whose structure is essentially head-to-tail, i.e. -CH_2-CF_2-(CH_2-CF_2)$_n$-CH_2-CF_2-. PVDF is approximately 50% crystalline and 50% amorphous. The principal crystalline forms of PVDF are the highly polar ß form and the non-polar α form shown in Figure I. High piezo response is associated with the polar ß form in which the hydrogen and fluorine atoms are arranged to give the maximum dipole moment per unit cell. The dipole moments of the crystallites are randomly oriented with respect to each other unless the film is electrically polarized. Pennwalt produces KYNAR Piezo Film by means of carefully controlled processing steps which include mechanical orientation and treatment in an intense

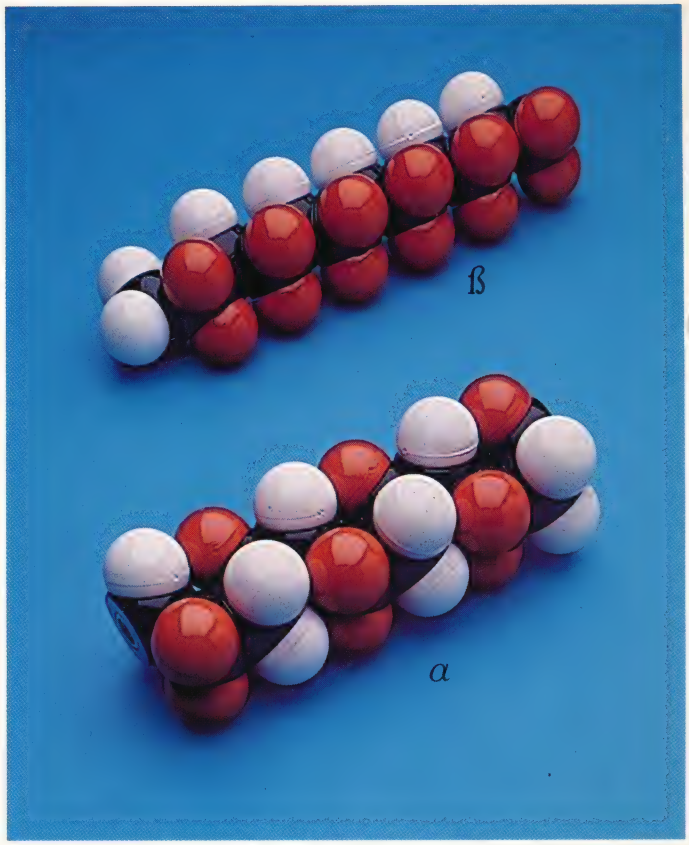


Figure I

electric field. The resulting product containing predominantly oriented ß form crystallites exhibits a large net polarization. It is this net polarization that gives the film its high piezoelectric and pyroelectric activities.

KYNAR Piezo Film—Unique Characteristics

The basic characteristics that make KYNAR Piezo Film unique and useful in many electronic transducer applications are:

- ☐ High pyroelectric sensitivity.
- ☐ High piezoelectric sensitivity in planar, thickness, and hydrostatic modes.
- ☐ Good fidelity throughout a broad range of frequencies.
- ☐ Low mechanical and acoustic impedance.
- ☐ High dielectric strength—much higher than ceramics.
- ☐ Resistance to moisture and high humidity.
- ☐ Tough, flexible and lightweight.
- ☐ Available as thin film—readily cut and shaped to form complex configurations.
- ☐ Easily laminated to produce bimorph and multimorph elements which multiply transducer response.
- ☐ Not subject to breakage and loss of dipolar properties when subjected to mechanical impact.

Properties of KYNAR Piezo Film
and other Materials (in Length Expansion Mode)

Materials	Cut	Density	Elastic Stiffness	Relative Dielectric Constant	Piezoelectric Constant				Coupling Factor	Acoustic Impedance
		ρ_3 kg/m^3	c^2 N/m^2	ϵ/ϵ_0	d m/V (coul/N)	e N/V m (coul/m^2)	g V m/N	h V/m	k calculated	z kg/m^2 sec
		(10^3)	(10^9)		(10^{-12})	(10^{-2})	(10^{-3})	(10^7)	(%)	(10^6)
Quartz	X	2.65	77.2	4.5	2	15	50	380	10	14.3
Rochellesalt	45°X	1.77	17.7	350	275	490	90	160	73	5.6
PZT	Z	7.5	83.3	1200	110	920	10	90	30	30
BaT_2O_3	Z	5.7	110	1700	78	860	5.2	60	21	30
Kynar Film	Z	1.78	3	12	23	6.9	200	65	12	2.5

KYNAR Piezo Film Properties

The level of piezo activity in KYNAR Piezo Film may be readily determined by standard test methods.

The coordinate system showing the piezo constants, d_{31}, d_{32}, and d_{33} are illustrated in Figure II. The first index (subscript 3 on d_{31}) specifies the electrical (polar) axis. The second index (subscript 1 on d_{31}) indicates the mechanical (stress or strain) axis. These constants along with typical basic properties of KYNAR Piezo Film are listed in Table I.

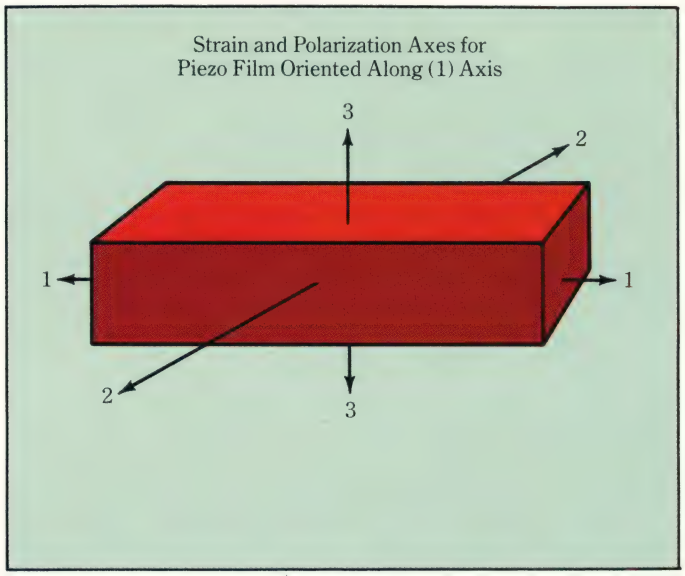


Figure II

The changes in several properties with frequency and temperatures are shown in Figures III through VI on page 3. The thermal stability of piezo activity as shown in Figure III demonstrates that after an initial decay, piezo activity becomes very stable. Most of the decay below 100°C is caused by thermally induced mechanical relaxation and is not related to depolarization effects.

Figure IV illustrates the dependence of dielectric permittivity and dissipation factor on frequency at ambient temperature. As a result of its relatively low dielectric permittivity (100 fold less than piezo ceramics), the g-constants (voltage output coefficients) of PVDF are significantly greater than those of ceramics. Thus PVDF can be made into very responsive sensors of mechanical signals.

The relationships between electrical impedance and frequency for various thicknesses of KYNAR Piezo Film, 100 sq. cm in area, are shown in Figure V. These data are important for matching film impedance to associated components in the circuit. The influence of frequency on the electromechanical coupling factor "k_{31}" is shown in Figure VI. Although k_{31} and therefore the efficiency of energy transfer is low compared to ceramic transducers, KYNAR Piezo Film elements can be used at much higher fields than ceramics which result in desirable mechanical deflections. For example, because its dielectric strength is 70 times that of PZT ceramics, the maximum input capability for electrical energy of PVDF is 40 times greater and the corresponding output of mechanical energy is 5 times greater.

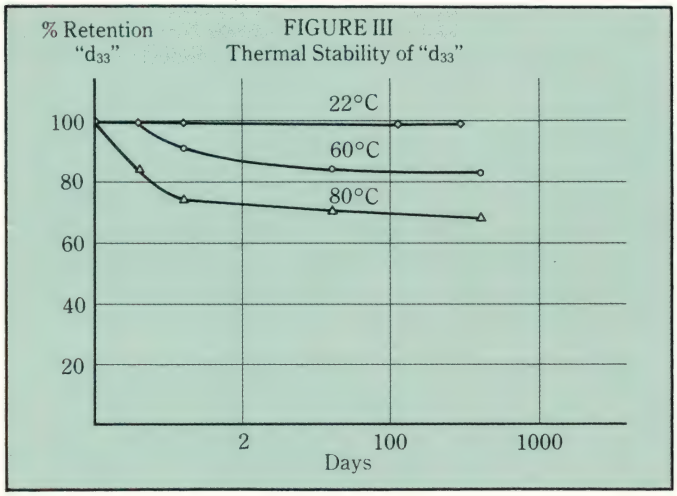


FIGURE III
Thermal Stability of "d_{33}"

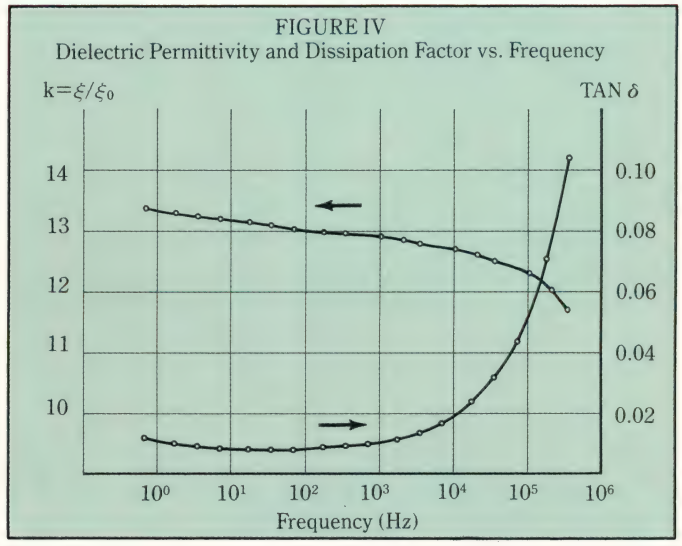


FIGURE IV
Dielectric Permittivity and Dissipation Factor vs. Frequency

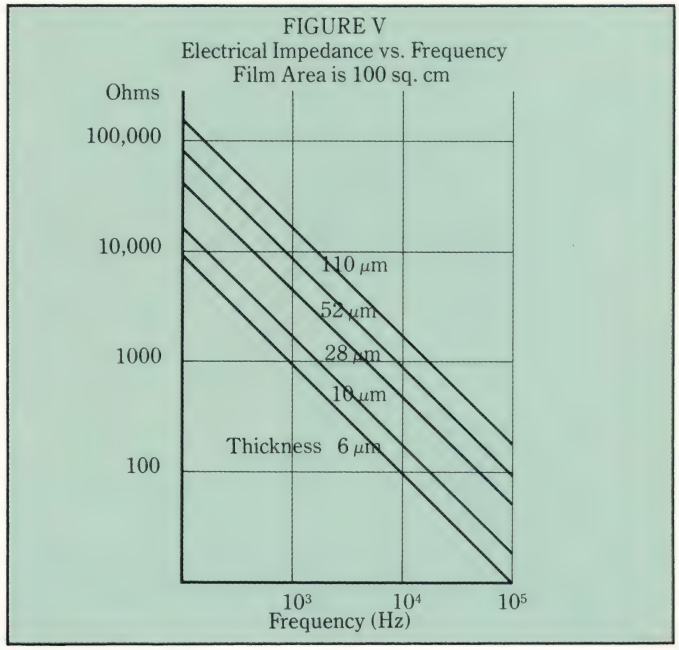


FIGURE V
Electrical Impedance vs. Frequency
Film Area is 100 sq. cm

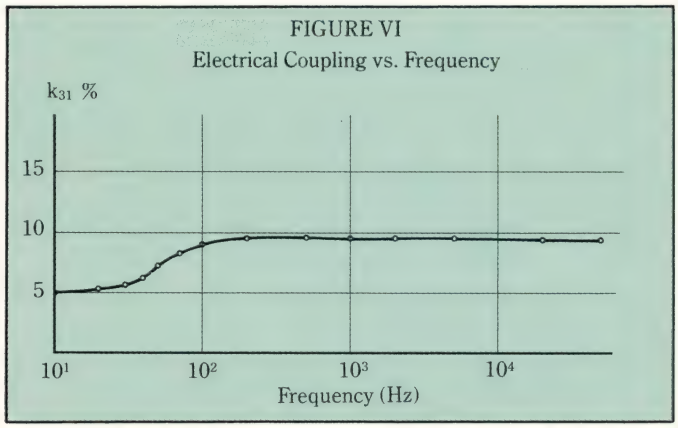


FIGURE VI
Electrical Coupling vs. Frequency

TABLE I
TYPICAL PROPERTIES OF KYNAR PIEZO FILM

PROPERTY		VALUE	UNITS
Thickness		6-125	μm
Surface Conductivity of Metallized Film	Al	1-4	$\Omega\,\square^{-1}$
	Ni	10-25	
Static Piezoelectric Strain Constant	d_{31}	20-25	pCN^{-1} (pmV^{-1})
	d_{33}*	20-22	
Static Voltage Output Coefficient	g_{31}	0.230	VmN^{-1}
	g_{33}	0.210	
Electromechanical Coupling Factor	k_{31}	9-15	% at 100 Hz
Pyroelectric Coefficient	p	23-27	$\mu Cm^{-2}{}^{\circ}K^{-1}$
Shrinkage in Machine Direction	60°C	2	% after annealing 100 hrs.
	80°C	4	
Relative Dielectric Permittivity	ϵ/ϵ_0	12 ± 1	at 1000 Hz
Dielectric Loss Factor	tan δ	0.015-0.02	at 1000 Hz
Volume Resistivity	ρ	10^{13}	Ωm
Tensile Strength at Yield	MD**	–	$10^6 Nm^{-2}$
	TD**	40-110	
Tensile Strength at Break	MD	160-330	$10^6 Nm^{-2}$
	TD	30-55	
Elongation at Break	MD	25-40	%
	TD	380-430	
Young's Modulus of Elasticity = Elastic Stiffness = c^E	MD	1.5-3	$10^9 Nm^{-2}$
	TD	1.1-2.4	
Melting Point		165-180	°C
Flammability, LOI		44	$\%O_2$
Thermal Conductivity		0.13	$Wm^{-1}{}^{\circ}K^{-1}$
Specific Heat		2.5	$MJm^{-3}{}^{\circ}K^{-1}$
Density		1.8	$g(cm)^{-3}$
Thermal Expansion Coefficient		1.4	$10^{-4}{}^{\circ}K^{-1}$
Sound Velocity***		1.5-2.2	kms^{-1}

*measurements were made in hydraulic press (e_{33}/c_{33}) **MD = Machine Direction (1) and TD = Transverse Direction to film orientation (2)
***longitudinal and thickness modes.

Audio Applications: as the active element in microphones and stereo pickups, and in speakers and headphones, KYNAR Piezo Film affords lightweight, compact design, easy formability to desired geometry, and high fidelity response. It has low acoustic and mechanical impedance and is well-suited for the design of noise-cancelling microphones.

Switching Components: as patterned switch elements in "finger-pressure touch action" keyboards and key pads for typewriters, telephones and computer terminals, KYNAR Piezo Film has virtually unlimited life. Such switches have been tested for millions of operations without failure. These elements are also useful in impact detectors, coin sensing systems, and actuators for explosives.

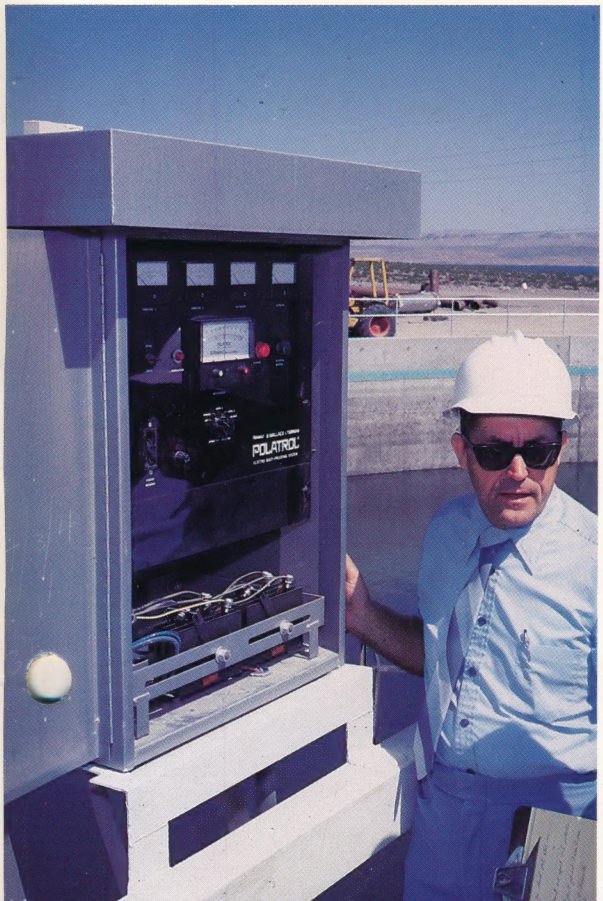
Instrumentation: as sensors for instruments used to monitor vibration, deformation, acceleration, pressure, fluid flow, and seismic pulses. In medical applications as sensors for monitoring heartbeat, breathing, and blood flow.

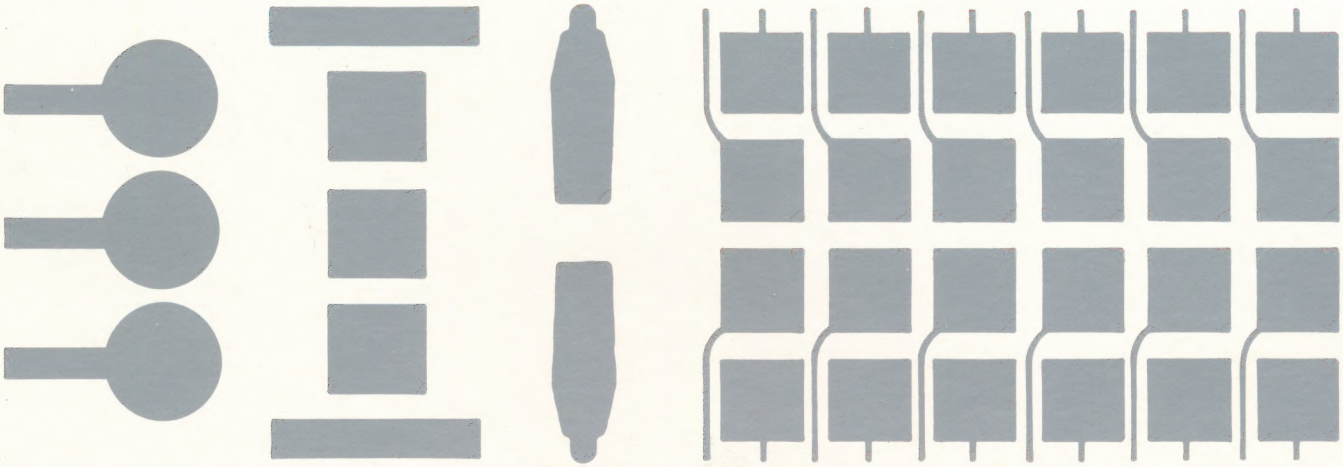
Ultrasonic Sensing: because its acoustic impedance is close to that of water and body tissue, KYNAR Piezo Film is an excellent choice for applications in medical imaging equipment. It is also being evaluated for non-destructive testing instruments and for range-finding systems.

Underwater Sound Detection: as large, flexible elements for hydrophones, sono-buoys and towed arrays used for submarine detection and oil exploration.

Heat sensors: because of its excellent electrical response to incident infra-red radiation, KYNAR Piezo Film is used in intrusion and fire alarms, heat scanners, and pyroelectric energy control systems. It also shows promise for applications in infra-red imaging equipment and electrostatic copying.

Flexure-mode Transducers: as bimorph constructions in motion displays, "motorless" fans, pumps, shutters and position sensors.





Film Thickness

KYNAR Piezo Film can be supplied in a range of thicknesses, from a few microns to several hundred microns.

Thin films are recommended where a high efficiency of conversion of electrical signals into mechanical motion is needed as in headphones, speakers, and bimorph designs utilizing the d_{31} mode. Thin film is also preferred for pyroelectric applications where rapid response is required.

Thick films are recommended in applications where a voltage is generated by thickness change or hydrostatic pressure. An example is sonar transducers for underwater sound detection.

Bimorph Elements

KYNAR Piezo Film is readily laminated into bimorph stacks, which increase the mechanical motion generated in cantilever devices. Either series or parallel arrangements can be used. This technique is also applicable to sensors as a means of multiplying electrical output.

KYNAR Piezo Film is available in the following forms and styles:

- ☐ Continuous rolls
- ☐ Sheets
- ☐ Various thicknesses
- ☐ Unmetallized and metallized surfaces
- ☐ Custom-metallized patterns (above)
- ☐ Specialized elements to customer specifications

Pennwalt is supplying KYNAR Piezo Film and customized elements to companies throughout the world for use in commercially available products as well as for many new products under development.

For further information and technical service contact the KYNAR Piezo Group, Pennwalt Corporation, 900 First Avenue, P.O. Box C, King of Prussia, PA 19406-0018, (215) 337-6750 or call toll free (800) 345-8112; in Pennsylvania, (800) 662-2444.

PENNWALT
CHEMICALS ■ EQUIPMENT
HEALTH PRODUCTS

KYNAR™ PIEZO FILM

KYNAR™ Piezo Film brings you a combination of characteristics never before available: a flexible film with the highest piezoelectric and pyroelectric activity of any polymer, available in large sheet sizes, easy to form into complex shapes, and free of the limitations of fragile, brittle and hard-to-fabricate crystals and ceramics.

No wonder KYNAR Piezo Film is being used successfully in applications such as these:

Audio applications. Microphones, headphones, speakers. KYNAR Piezo Film has low acoustic and mechanical impedance, and frequency response from DC to GHz.

Switches. Keyboards and keypads for typewriters, telephones, computer terminals. High resistance to impact and fatigue means film won't shatter or deform over millions of touch operations.

Industrial and Medical Instrumentation. As sensors for pressure, vibration, strain and fluid flow. Medical equipment: for ultrasonic imaging, for monitoring of heartbeat, and measuring respiration and blood flow.

Underwater Sound Detection. As elements for hydrophones and sonobuoys. Acoustic impedance is close to that of water.

Heat sensors. For fire and intrusion alarms and for energy control systems.

Motion Devices. For displays, shutters, position sensors, "motorless" fans.

KYNAR Piezo Film is available in commercial quantities, in a range of thicknesses, sizes, and types of metallization to meet designers' needs. For technical data, price and delivery information, and assistance in customized applications, call toll-free (800) 345-8112, in Pennsylvania, (800) 662-2444, or write to: KYNAR Piezo Group, Pennwalt Corporation, 900 First Avenue, P.O. Box C, King of Prussia, PA 19406–0018.

It's sparking a transducer revolution.

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